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Dekkers, G.J.M.

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Intergenerational Redistribution of Income through Capital Funding Pension Schemes

Gijs J.M. Dekkers

Intergenerational Redistribution of Income Through Capital Funding Pension Schemes:

Simulating the Dutch Civil Servants' Pension Fund ABP.

Proefschrift

ter verkrijging van de graad van doctor aan de Katholieke Universiteit Brabant, op gezag van de rector magnificus, prof.dr. F.A. van der Duyn Schouten, in het openbaar te verdedigen ten overstaan van een door het college voor promoties aangewezen commissie in de aula van de Universiteit op vrijdag 15 december 2000 om 11.15 uur door

Gijsbrecht Johan Martin Dekkers

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Voorwoord

"Maar de tijd verstrijkt, de toorts van de tijd schenkt licht, vindt verbanden, legt betekenis in verwarring, onthult de waarheid". Dit citaat van Paul Theroux is een manier om uit te drukken waarom dit proefschrift zo lang op zich heeft laten wachten. Een andere manier zou zijn geweest dat het tegelijkertijd uitbouwen van een loopbaan, verliefd worden, trouwen, meerdere keren verhuizen, en het in de avonduren verderwerken aan een proefschrift, geen gemakkelijke opgave is gebleken.

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Dr. Jan Nelissen heeft me ingewijd in de geheimen van dynamische microsimulatie, meer bepaald in het model NEDYMAS. Zijn onvermoeibare begeleiding, onze soms felle discussies en de avonden in de Tilburgse kroegen hebben een enorme positieve invloed gehad.

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Dit proefschrift was af toen het klaar was. Het is slechts in één opzicht te laat gekomen: dat Peter Hovestadt het niet meer heeft kunnen lezen.

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Part I:

Problem Definition.

Introduction.

As is the case in most developed countries, the population in the Netherlands is ageing rapidly. The number of individuals older than the mandatory retirement age of 65 expressed as a fraction of the rest of the population will increase from 21.2% in 1995 to about 43.6% in 2050[1]. In most countries, the largest proportion of the pension benefits which are paid out to the elderly are brought together by the contributions of the active population. This type of financing is known as a Pay-As-You-Go-scheme (PAYG, see Miles and Timmermann, 1999, p. 255). Consequently, an important 'chain of solidarity' between the generations exists via the PAYG-scheme in these countries: every generation covers for the pension of the preceding generation. There is however increasing strain on the chain: as a result of ageing, the proportion of elderly in the population increases. So, fewer contributors must cover for the pension benefit of more beneficiaries. Hence, the active population will see their pension contributions increase, whereas the future pension benefit they can expect, will not change. How much will the contribution rates increase? Will the contributors accept these increasing costs, or will they someday push their political representatives to abolish the pension scheme and thereby break the solidarity-chain? The fact is that, given a certain relative pension benefit, the members of some generations pay more than members of other generations. So, there is a pattern of winners and losers which is caused exactly by the rates of ageing of the populations, in combination with PAYG-pension schemes.

One of the policy measures which is generally believed to be able to prevent this breakdown from happening, concerns the development of additional pension schemes based on the Capital Funding (CF) type. In these pension schemes, individuals of every generation contribute to a pension fund, and thereby build up a certain future pension claim. So, every generation on builds up its own future pension benefit in this type of scheme. The advantage then is that there are no winners or losers, from the generational point of view at least, so that demographic developments cannot jeopardize the system.

Capital funding pension schemes are believed not to rely on income flows between generations, since every generation on finances its own future pension. And in theoretical models,

[1] CBS&CPB, 1997, table 7.3, p. 40.

this is indeed the case. However, pension funds do not operate in a theoretical world; they are part of a very realistic world, with all its insecurities and risks. In this study, we will argue that the argument that CF-schemes do not cause intergenerational income flows is a too optimistic view in the sense that the way Capital Funding schemes are implemented and organized by pension funds in practice, cause intergenerational redistribution of income to happen, though not as strongly as in the case of PAYG schemes.

The central question is whether intergenerational redistribution of income occurs via a Capital Funding pension scheme as it is organized by a fund in practice. And, if so, how important is this redistribution of income between generations? And what causes it? Finding the answer to these questions is the core of this research project and this will be done by simulating an existing pension fund, namely the Dutch civil servants' pension fund ABP.

The first part of this study will start by a discussion of the history and current state of the Dutch pension system, where the emphasis will be on the system of additional pensions. Next, in the second chapter, reasons for intergenerational redistribution of income within additional pension schemes will be presented, together with the cost-increasing effect of ageing, and possible solutions to these cost-increases. After that, a way to measure these solidarity flows will be put forward in the first paragraph of the third chapter. It will be argued that microsimulation best meets the demands imposed by the research problems formulated above. The dynamic microsimulation model NEDYMAS[2] will then be presented, after which the simulation of lifetime income and the measuring of intergenerational redistribution of income will be returned to.

In the second part, the module representing the civil servants' pension fund which was linked to the core of the microsimulation model NEDYMAS, will be presented and discussed.

The third part contains the core of this research project, and consists of the presentation and discussion of the base-simulation results. The intergenerational income flows within the simulated pension fund will be presented, and it will be shown how vulnerable these flows are to some partial changes.

The social relevancy of the research problems is the following. It will be argued that the conditions for the existence of intergenerational substitution of income most likely are met. This

[2] NEDYMAS is an abbreviation of NEtherlands DYnamic MicroAnalytic Simulation system.

could mean that, given the current rate of ageing, a heavy and rapidly growing financial burden would be put on every successive generation. Eventually, this could result in the collapse of (parts of) the pension system in the Netherlands, which would make everybody worse off. The practical dilemma could therefore be that the current generation has to cut back the pension system, in order to save it for the future.

This conclusion makes discussions about levying taxes on pension funds, on the level of the internal rate of return of pension funds and on expectation errors on ageing very important, for it directly influences the income of current and future participants of these pension funds.

On the scientific relevancy of the problem, the main argument lies in the fact that this study is part of an increasing scientific attention to the causes and effects and problems of ageing, where it can fill a gap between the empirical pension models, which are mostly macro- or meso-economic, and the analytical models, which are mostly highly theoretical and difficult to use for practical policy problems. The second reason why this study is scientifically relevant lies in the fact that a dynamic microsimulation model is combined with a module describing an existing pension fund, i.e. the public servants pension fund (Algemeen Burgerlijk Pensioenfonds or ABP).

Chapter 1. Definitions and the current situation of the Dutch old-age pension system.

Introduction

This study deals with the possible existence of intergenerational redistribution of income through Capital Funding pension schemes, such as the civil servants' pension fund ABP. To appreciate the social relevancy of this problem and to place it in a societal context, the Dutch pension system will be presented and discussed in this first chapter. In this, the system of additional pension schemes as organized by pension funds will be emphasized upon. Some definitions which are necessary for a good understanding of what follows, will be presented in the first paragraph. Next, the Dutch pension system will be outlined in the second paragraph. The third paragraph will then concentrate on the system of additional pension schemes, starting by making a classification of these schemes. In the fourth paragraph, the Dutch civil servants' pension fund ABP (Algemeen Burgerlijk Pensioenfonds) will be presented in more detail. It is this pension fund which will be modelled to gain insight into intergenerational redistribution of income.

1.1 Definitions.

In this paragraph, some necessary definitions will be presented. Petersen defines a pension as a benefit which one becomes eligible to, given that a certain, well defined event takes place (Petersen, 1990, p.17). This event can be that one reaches the mandatory retirement age of 65[3] (in the case of an old age pension) or the death of the spouse or one or both of the parents, given that one is a minor, in all of which cases one is entitled to a widowers/orphans pension. Lutjens (Lutjens, 1994, p.54) argues that a general definition of a pension such as the one above, should be that broad that it is necessarily vague. He does give some general characteristics a system should have in order to be a pension. These characteristics are (i) an individual is eligible when labour income falls off, (ii) the reason for the ending of the labour income is permanent, and (iii) the allowances are

[3] At least, everybody becomes eligible for the state pension AOW at the age of 65, and 95.4% of those who are participating in an additional compulsory pension scheme face the same retirement age. See Pensioenkamer, 1989, section 3.3.

periodical, non-redemptive and non-transferable. It is remarkable that the juridical definition of pension schemes is to be found in the laws concerning the wage tax (Wet op de LoonBelasting); this highlights the idea that occupational pensions payments are seen as postponed wage payments (Petersen, 1991, p.41, Lutjens , 1994(b), p.55). This definition is also one where a pension scheme is defined in terms of an obligation to provide an income for (a) former and current employees in the case of invalidity and/or old age and for (b) their partners and unmarried children under the age of 21. The level of this income is determined by what is seen as reasonable by society, taking into account the number of years worked and the payment received when working. In this definition, both the solidarity principle and the insurance principle can be found.

There are three general financing methods, of which two are relevant in this context. First of all, the pension claim of the pensioners can either be financed in the same period by those who are not retired at that moment. If this is the case, the funding scheme is referred to as a Pay-As-You-Go-scheme (or PAYG-scheme). Alternatively, the pension claim of the pensioners can be financed by past contributions by these current retirees, in which case there is a Capital Funding Scheme (or CF-scheme). In the case of a PAYG-scheme, the pension benefits paid out to the beneficiaries in a certain year are directly financed by contribution payments by the active population. This means that the members of each generation, while being young, pay for the pension of the members of the preceding generations. In other words, in a certain year, total outgoing benefits are equal to incoming contributions and no funds are created. In contrast, in a CF-scheme, each generation saves for its own (future) pension benefit, at least in principle, and this implies that funds are created. If pension claims are financed through a CF-scheme, the participants pay a certain contribution rate to a pension fund, which grants them a certain claim for a future pension. A pension fund can therefore be defined as an organization whose task it is to secure pension claims of present and past participants of a pension scheme. The 'payment obligation' or the total debt of the pension fund with respect to its participants, is defined as the net present value of the total claims (van Aalst, 1993).

The third financing method is not, or very seldom used for financing old age pensions, and will therefore only be discussed briefly. This method, called the Interest Coverage method, means that the funds necessary to finance the total pension benefit of an individual are reserved in the year that this individual reaches the age of 65. So, in one year, the active participants need to pay enough contributions to cover the total present value of the future pension claim of those who become eligible to such a benefit in that same year. This means that there are no pension savings, apart from funds for ongoing pension claims: in the case of bankruptcy of the firm, the future pensions of the active participants are jeopardised, as they did not save for their own pension, but covered the pension claim of others instead. This financing method is sometimes used for early retirement schemes and individual invalidity insurances (Enting et.al,1995, p.19).

Having defined what is meant by pensions and what financing methods there are, the Dutch pension system will be outlined in the next paragraph.

1.2 Pensions in the Netherlands: an outline.

It is a well-known fact that the Dutch system of social security is one of the most developed in the world, be it in terms of turnover of money or in terms of coverage. This is also the case for the system of old-age protection. In 1994, the total (old-age)pension contributions equalled about 91 billion guilders[4] (approximately equal to 36 billion US$), whereas the sum of old-age benefits received was equal to 87.4 billion guilders (about 35.3 billion US$)[5]. This is respectively about 12.8 and 12.3 percent of GDP (almost 709 billion guilders in the same year[6]). In this paragraph, the Dutch pension system will be described in broad lines.

As is the case for the Dutch social security system as a whole, the Dutch pension system still reflects the ambiguity between the solidarity principle and the insurance principle proposed by the Commission van Rijn (Hertogh, 1992). The Dutch pension system consists of three levels, namely the basic pension system, the supplementary pension system and the private-pension system. The first level consists of the General Old-Age Act (AOW) and -when pensions are defined in the broad

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[4] A)This includes (employees-)contributions on AOW and AWW/Anw and employers' and employees' contributions on the VUT and to pension funds and insurance companies (see Nationale Rekeningen 1997, table S60.6, p.109 and table S50.1, p. 101).
B) 1euro=0,8913 (course May 3th 2000), 2,4725 FL=1 euro, so 1FL=0,40445$.

[5] Benefits from pension funds and insurance companies (see table S50.1, p. 101) and the AOW-, VUT and Anw-schemes (see table S60.7, p. 110)

[6] See Nationale Rekeningen, 1997, table M3, p. 13. For a more elaborate comparison of Dutch demographics and pensions with other EC-countries, see WRR, 1999, paragraph 5.5 and especially table 5.5 p. 160. See also Boldrin et. al., 1999, table 1, Miles and Timmermann, 1999, Mortensen (ed), 1992.

sense- the General Widows-and-Orphans Pensions Act (AWW). On 1 July 1996 the AWW was replaced by the General Act for Surviving Relatives (Algemene Nabestaandenwet, Anw). These regulations provide a base level of protection to all current or former residents of the Netherlands. The General Old-Age Act provides every current or former resident older than 65 with a flat-rated benefit, equal to a certain percentage of the net minimum wage and dependent on the marital status of the individual. A participant implicitly builds up 2% of the AOW-benefit for each contribution year: this implies that any individual 'loses' 2% of the full AOW (given the marital status) for every year between the age of 15 and 65 that he or she has been living abroad. The contribution rate is set such that the expected contributions are equal to the expected benefits in a certain year, and is in 1998 equal to 16.5% of the gross income between the tax exemption and the first tax bracket (in 1996 at most fl. 45,325 or about 18,331 US$). As the benefits are flat-rated, whereas the contributions are not, at least not up to a certain maximum, the AOW is redistributive within generations. Moreover, the fact that the AOW is financed through a PAYG-system, makes the contribution rate dependent on the population structure, more specifically the rate of ageing, entailing that the AOW also leads to intergenerational redistribution of income. The AOW is organised and controlled by the Social Insurance Bank (Sociale Verzekeringsbank), which provides an AOW-benefit to about 2.27 million beneficiaries, summing up to 36.6 billion guilders, about 14.80 billion US$[7]. The AOW-benefit depends on the household situation of the individual. Unmarried beneficiaries without young children receive a benefit equal to 70% of the net minimum wage. On 1-1-1998, this benefit was fl. 1,638.36 or 662.63 US$ per month. Married or cohabiting individuals both of whom are 65 or older, each receive 50% of the net minimum wage, being fl. 1,123. 27 or 454.31 US$.

The General Widows-and-Orphans Pensions Act (AWW) and its successor, the General Act for Surviving Relatives (Anw) are not part of the core of this study, so they will not be discussed.

The second level of the Dutch pension system consists of the (semi-) collective supplementary pension schemes, which are organized and controlled by pension funds which work on enterprise, branch and profession level. These pension funds collect the contributions of workers and promise a certain future pension benefit (usually related to the past wage and the number of

[7] Figures 4th quarter of 1998 (SVB, Kwartaalbericht AOW, Anw, AKW, vol. 8, no 4, March 1999, table 3.3.8. The benefits are from 1997, source: CBS, Nationale Rekeningen 1997, table S60.7, p. 110).

contribution years). As at 1998, savings held by pension funds amounted to 1,162 billion guilder (WRR, 1999, p. 169). This makes the Netherlands the country where this form of pension saving is the most developed in the world, both as a percentage of GNP and personal sector assets (Mortensen, 1992, table 1, p.107). The next paragraph will concentrate on this second level of the pension system.

The third level is the whole of private, individual and voluntary pension saving schemes and life-insurances. Here, contributions as well as benefits are completely individual. This level is of less importance given the research problems of this study and will therefore not be discussed.

In accordance with the system of social security as a whole, the AOW is dominated by the solidarity principle and the sum of benefits for the elderly is paid for by the working members of the younger generation. The supplementary pension schemes are to a greater extent dominated by the equivalence principle. Everyone in principle finances his or her own average future pension. The relation between contribution and expected benefits is therefore much stronger, at least as compared to the AOW.

In the first paragraph, funding methods were classified. In the second paragraph, the Dutch pension system was outlined. The third paragraph will concentrate on the second layer of this pension system, which consists of pension funds offering additional pension schemes, financed by Capital Funding. It will start with a classification of pension funds as well as the pension schemes which these funds use. After that, the system of additional pension schemes in the Netherlands will be discussed.

1.3 Capital Funding pension schemes.

1.3.1 Classification of additional pension schemes.

One important thing which can be said about the second level, the Dutch system of additional compulsory pensions, is that it is far less surveyable than the first level, the General Old Age Act. This is why it can also be described as a 'pension situation' rather than a pension scheme (Bouckaert, 1988, in Dekkers, 1998). Pension funds can be separated into various groups, of which the common factor is that the pension claims are financed by a capital funding scheme. It is this classification which will be given in this paragraph.

The first group of pension funds which can be mentioned are the firm pension funds, which organize pension schemes for employees of individual (often large) firms like Philips, Shell, Akzo and so forth. Next, there are industry-wide pension funds, large pension funds which organise pension schemes for all firms in a certain branch of industry. For firms in that branch of industry, participation is often compulsory, following the Act on Compulsory Participation in Industry Wide Pension Funds (BEF.). There are many more firm pension funds than industry-wide pension funds, but firm pension funds are generally smaller than industry-wide pension funds, both in terms of active participants as of retirees. The third group of pension funds are the pension funds for professional groups such as medical practitioners, lawyers etc. The last group -denoted 'other pension funds'- consists of a small number pension funds, of which one is the Algemeen Burgerlijk Pensioenfonds or ABP, which organizes and executes pension schemes for civil servants. The numbers, absolute as well as relative, are shown in table 1.1[8].

Table 1.1: classification of pension funds according to category.

	number of funds	number of active participants	number of pension beneficiaries
firm pension funds	842	729378	353718
	89.670	17.600	21.500
industry pension funds	77	2374623	774889
	8.200	57.300	47.100
pension funds for professional groups	11	37297	11516
	1.171	0.900	0.700
other pension funds	9	1002895	505076
	0.958	24.200	30.700

The numbers in the even rows denote percentages of the column-total: in other words, the number 89.6% in the first column of the first row implies that 89% of all pension funds (which is 939) are

[8] The numbers are based on Verzekeringskamer, 1995, table 3.2.2.1. and describe the situation at the end of 1994.

firm pension funds.

Based on the information in table 1.1, several observations can be made. First of all, firm pension funds outnumber industry-wide pension funds, but they are considerably smaller in terms of numbers of active participants and numbers of pension beneficiaries. The average number of active participants is 866 for firm pension funds and no less than 30,839 for industry-wide pension funds. This is not surprising, since the difference between both types of pension funds is the level on which they operate. Therefore, even though industry-wide pension funds form only 8,2 percent of all pension funds, they incorporate 57% of all active participants and 47% of all pension beneficiaries.

Secondly, the group 'other pension funds' is a rather strange group, at least at first sight. Although it consists of only 9 pension funds, no less than 24% of the active participants and 30% of the pension beneficiaries are incorporated in this group. This makes it the second group in size, even more important than the group of firm pension funds. The reason is that this group 'other pension funds' includes the civil servants' pension fund ABP, together with some savings funds (which offer collective savings scheme to their participants) and some specific small pension funds. The ABP is one of the largest pension funds in the world and certainly the largest pension fund in the Netherlands and its inclusion in the group 'other pension funds' explains its importance. A third and last remarkable thing is that the ratio of pension beneficiaries and active (contributing) participants differs considerably. This ratio is about .3 for industry-wide pension funds and pension funds for profession groups and .48, resp. .5 for firm pension funds and 'other pension funds'.

The various pension arrangements, which are all financed by a CF-scheme, can be classified and clarified using figure 1.1 (Petersen, 1990, p.60). Pension arrangements can roughly be divided into schemes where the wage is the key variable, and those where it is not. In the <u>wage-related pension schemes</u>, the wage which an individual earns somehow determines the future pension benefit, and the contribution rate is the result. In the case of the <u>available premium system</u>, the relationship is reversed: the contribution rate and the wage determine the contribution, and the (future) pension benefit result. The (future) pension benefit, as well as the contribution, are an exogenous and fixed amount of money in the case of a fixed-amount system. As will be shown later, wage-related pension arrangements are used by almost 96% of the pension funds in the Netherlands,

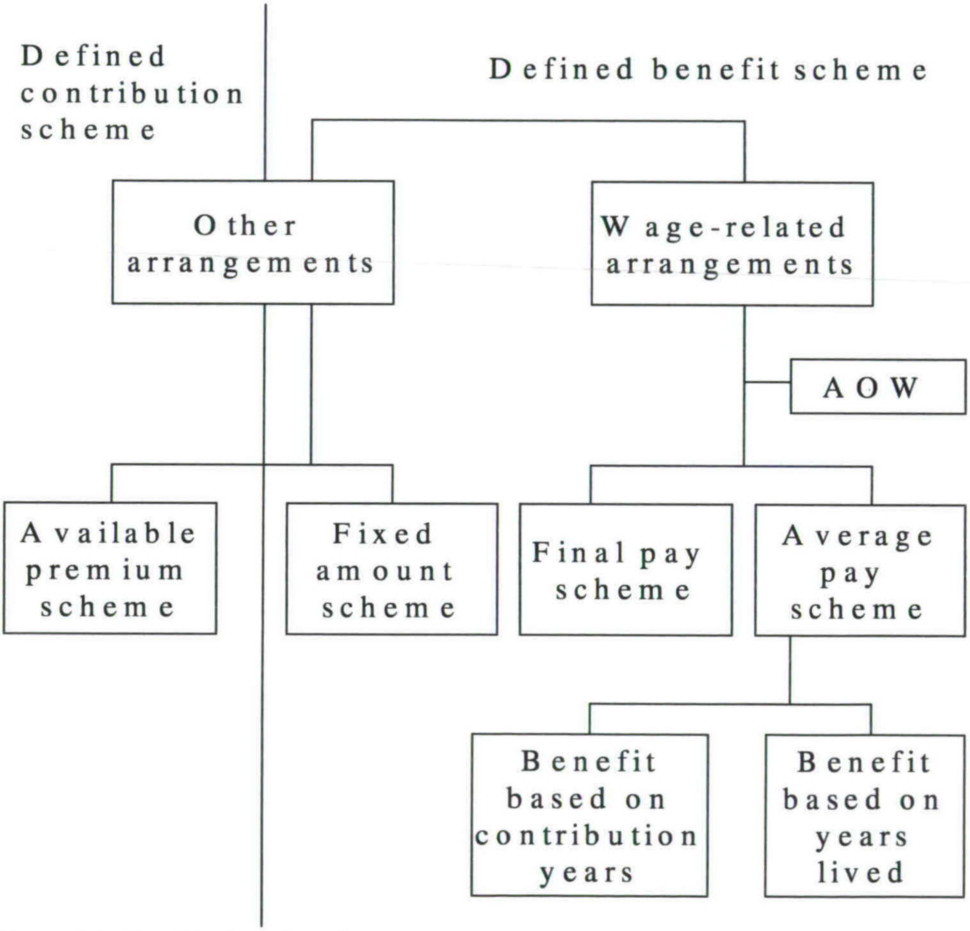

Figure 1.1: Classification of pension arrangements.

so they are by far the most popular. For various reasons, this situation might however change in the future, as will be discussed later.

Another classification, often used in Anglo-Saxon literature, is in defined-benefit schemes, where the future pension claim determines the contributions, and defined-contribution schemes, where the contributions determine the future pension claim. As can be seen from the figure, the category of defined-benefit schemes consist of wage-related schemes and the fixed-amount system and the category of defined-contribution schemes consists only of the available premium system.

In the next paragraph, the wage-related pension arrangements will be discussed. Paragraph 1.3.2 will then be devoted to other pension schemes.

1.3.2. Wage-related pension arrangements.

As said, in this first group of pension arrangements, the wage-related pension arrangements, the pension outcome as well as the contributions are in some way related to the wage an individual earns, relative to other pension arrangements. Arrangements of this type are based on the equivalence principle, which means that the contributions as a whole must cover for the future pension benefit which has been gathered (see Petersen, 1990, p. 189 and 190). Pension funds in the Netherlands have committed themselves to provide those who have been contributing to the pension fund for 40 years with a total pension benefit of 70% of a certain gross wage-base, taking the gross AOW benefit-level (including holiday-benefit) into account. How this wage-base is exactly determined, depends on the specific arrangement. This will be dealt with later. The level of the AOW-benefit has generally been taken into account when determining the additional pension benefit. There are two ways to do this. The first one is referred to as the <u>built-in method</u>; this method simply implies that the pension fund must fill up the pension income up to 70% of the wage minus the actual AOW-benefit. The second method, the <u>exemption method</u>, is much more common. The underlying thought is that part of the wage which one earns should cover the AOW. Therefore, the base for the occupational pension is the wage minus that part of the wage which covers the AOW. If the total pension is to equal 70% of the wage, then the part of the wage, which is used to cover the occupational pensions, is derived as follows:

$$
\begin{aligned}
\text{occupational pension} &= \text{total pension - AOW} \\
&= 70\%\ \text{wage - AOW} \\
&= 70\%\ [\ \text{wage - (100/70) AOW}\ ] \\
&= 70\%\ [\ \text{wage - exemption}\ ]
\end{aligned}
$$

The exemption is thus 10/7 times the AOW. To give an example, assume an individual who earned fl. 36,000 in 1999. The AOW equals 70% of the net minimum wage of 1998, and is thus equal to fl. 19662 (excl. holiday allowance). The total pension income after 40 years of contributing equals .7*36,000 = 25,200, and the additional pension benefit according to the built-in method therefore equals 25,200-19,662=5,538. The additional pension benefit when the exemption method is used, equals .7*(36,000-(10/7)*19,662)=fl.5,538[9].

Recently, exemptions which are not directly related to a AOW are becoming more and more popular, because they diminish the influence of demographic processes on the occupational pensions. An example is the use of the net minimum wage. Since January 1996, the pension fund for public employees, the ABP, uses an exemption equal to a fixed amount of money (Fl. 26,500) per annum. What happens if an individual does not earn more than the exemption? Then, a future pension of zero guilders is built up.

The next question when disentangling wage-related pension arrangements is in which ways wage determines the future pension level. Again, there are two possibilities: first of all, we have the final-pay system. This system is based on the thought that the pension level needs to allow an individual to maintain the life-standard he had during his active life. This means that the income he earned in the last couple of years before becoming 65 must be the point of departure for the determination of the pension (the wage-base). This is called the maintenance-principle.

Note that it is not common to fully include wage increases received in the last few years before retiring in the future pension benefit. This is to avoid the so-called 'pension-promotion', a large wage increase for a short period of time until retirement, which would lead to a permanent increase of the pension, of which the cost is not the direct concern of the employer or the employee anymore[10].

The second wage-related pension system is the average-pay system. Here, the basic thought is that pension is basically delayed wage, that the pension benefit and the contributions should be based on the same wage-base. One should therefore build up a pension yearly equal to 1.75 of the

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[9] Both methods lead to the same results, the difference occurs whenever the AOW-benefit is changed after an individual's date of retirement. In the built-in method, the occupational pension benefit changes whereas it does not in the case of the exemption method. Moreover, for part-time workers, the level of the exemption is adjusted *pro rata temporis.*

[10] In the Netherlands, the majority of the final wage schemes are 'limited'. For instance, in the case of the ABP, non-structural wage increases which occur in the last two years before the retirement age, are only reflected for 50% in the pension base.

wage earned that year (minus exemption). The total pension which one becomes eligible to after a career of 40 years then equals 70% of the average wage minus the exemption.

It is clear that an increasing wage over the career results in a higher pension outcome in the case of a final pay system compared to the outcome of an average-pay system, at least when the other parameters of the pension scheme remain unchanged[11]. So, a pension promotion is more effective in terms of the pension outcome which can be expected in the case of a final-pay system. Of course, the reverse holds as well: a decrease of the wage-base at the end of one's career is much worse, in terms of future pension benefit, in the case of a final-pay scheme than in the case of an average-wage scheme. The reason for this is that the pension depends on the income last earned and the number of contribution years. If the wage of the individual increases in some year, the future pension benefit to which he or she becomes eligible is a pension *as if he or she had been earning the new income from the beginning of his or her career*, and not (as it is) for only one year. This extra pension claim, resulting from an increase of the pension base, is called the backservice or backload. Would the same phenomena appear if we were to adopt the average-wage scheme instead of the final-pay scheme? Yes, but certainly much less strong, as the increase of the income would affect the pension base (the average wage) much less than it did in the case of the final-pay scheme. The backservice is much more important in the case of a final-pay scheme than in the case of a average-wage scheme and this will have far-reaching effects on the cost of a pension and possible intergenerational redistribution of income, as will be shown later. Having discussed wage-related pension schemes, other pension schemes will be discussed in the next paragraph.

1.3.3. Other pension systems.

In the final-pay scheme and the average-wage scheme, the (future) pension outcome was a certain fraction of the wage-base (either the final or the average wage, respectively), where this fraction depended on either the number of years worked or the number of years lived after the age of 25. In the following pension systems, this relation between the wage and the (future) pension

[11]An assumption which is often correct in the Netherlands (WRR, 1999, p. 182), but which does not always hold. Often, upbuilding percentages are increased to neutralize the overall effect of the decreasing wage-base.

claim is disposed. In the case of the available premium system or defined contribution system, the pension claim which one is entitled to is a direct function of the contributions paid in the past. In other words, the pension benefit is directly determined by the participant's total contribution during the active period of his life. Of the pension systems discussed so far, the defined contribution system best reflects the idea that a pension is postponed wage and it has several characteristics which has made it increasingly popular among those who want to decrease the collective cost of pensions, and make the individual more responsible for his or her own pension. In the first place, the fact that pension contribution and (future) benefit are strongly related in the defined contribution system makes the system less vulnerable to cost increases due to ageing and changes of economical circumstances. Apart from that, the system allows for more flexibility in deciding at what age one wants to retire, what premium one wants to pay, and so forth. The main drawback of the system is that the defined contribution system augments the participant's individual pension benefit-risk; it is very difficult to predict the level of pension one will receive when reaching 65 as this depends entirely on the unknown and possible highly variable rate of return of the pension fund.

The last system which we give for completeness' sake, is the fixed-amount system, where the pension allowance is a fixed amount of money, independent of the wage earned while being active.

In the above paragraphs, both pension funds as well as the types of pension which they offer have been presented and discussed. In the next paragraph, these classifications will be combined into one overview of the Dutch system of additional pensions.

1.3.4. The system of additional pension schemes in the Netherlands.

Various pension types have been discussed in this section. The obvious question is which pension fund is more likely to use which pension type? Consider the following table 1.2.
Table 1.2 shows what percentage of pension funds are of a certain type (as given in the first of each pair of columns) and use a certain system to determine the pension benefit (as given in the rows). The second of each pair of columns gives the percentage of all active participants which are enrolled in a certain pension fund using a certain pension type. The last two columns of table 1.2 contain the total number of funds and active participants which have adopted a pension system of one of the 5

types.

Table 1.2: classification of pension funds to pension type[12]

		final wage	average wage	available premium	fixed a-mount	others
firm pension	% funds	68.38	10.32	2.87	0.72	7.36
funds	%act.p.	15.87	2.09	0.04	0.02	0.13
industry	%funds	2.45	4.26	1.28	0.21	0
pension funds	%act.p.	34.91	20.13	0.92	0	0
funds for	%funds	0	0	0.53	0.64	0
professional groups	%act.p.	0	0	0.63	0.3	0
other	%funds	0.21	0	0.11	0	0.64
pension funds	%act.p.	24.9	0	0.06	0	0.03
total	funds	667	137	45	14	75
numbers	act.p.	3039812	892671	66040	12563	6200

According to this table, no less than 68% of Dutch pension funds are firm pension funds which use a final-pay system. This combination is clearly by far the most common among pension funds. However, as the average number of active participants in firm pension funds is lower than in industry wide pension funds (see table 1.1), the percentage of active individuals which are participating in firm pension funds with a final wage system is only 15.87. In terms of percentage of active participants, industry-wide pension funds with a final pay system are the most common in the Netherlands (with almost 35% of the active participants participating in such a fund). In second place, we find 'other pension funds' using a final pay system. As will be shown later, this is due to

[12] Data generated by own calculations, based on Verzekeringskamer, 1995, table 3.2.3.2; the data excludes savings funds. In the last row, the total number of funds is 938. The difference with the exact number of funds (939) is caused by rounding errors. The total number of active participants is 4017289.

the civil servants' pension fund ABP. Industry-wide pension funds using an average wage scheme are third in line (20%) and firm pension funds with a final pay system comes only fourth with almost 16% of the active participants.

It is clear that the wage-related pension systems (the final-pay system and the average-wage system) are by far the most popular, so for the vast majority of participants[13], there is some relation between the wage earned and their future pension benefit. Industry-wide pension funds seem to have more preference for average-wage systems (4.26% vs. 2.45%), whereas firm pension funds more often adopt the final-pay system (68.38% vs. 10.31%). A possible explanation for this difference is that the relationship between a firm and its own pension fund is often tighter than the relationship between a firm in a certain branch of industry and the pension funds which covers the pensions for the whole branch of industry. Consequently, in the case of the firm pension fund, the management of the firm can urge the funds' managers to adopt (or hold on to) the final-wage system, which is the most beneficial to the (current) employees, this in order to prevent compensating wage demands from unions (Mitchell and Smith, 1994). The pension types which are not wage-related, i.e. the available premium system, the fixed amount system or a combination of the two, are not very often used by firm pension funds or industry-wide pension funds. The opposite is the case with the pension funds for professional groups, where these schemes are the most popular. The reason for this could be that these pension arrangements are often the only (or one of the few) institutional relations between the members of the professional groups, which can be attached to their independency. So, there is less need for solidarity between the various participants, certainly not if this might cause the pension fund to create actuarial shortages.

This third paragraph started with a classification of pension funds into industry-wide pension funds, firm pension funds, pension funds for profession groups and other pension funds. Next, pension schemes were classified; the most important are final wage schemes and average wage schemes. Using all this information, the Dutch system of additional pension schemes is outlined. The next step is that the Dutch civil servants' pension fund ABP will be discussed in more detail.

[13] Namely 15.75+2.09+34.91+20.13+24.9=97.81%

1.4. The civil servants' pension fund ABP.

The civil servants' pension fund ABP, which is an abbreviation of 'Algemeen Burgerlijk Pensioenfonds', has a capital reserve of about 190 billion guilders, which is about 76.85 billion US$. As it is the goal to simulate this pension fund, it seems straightforward to take a closer look at the ABP and more specifically, how its contribution rates and benefit rates are set. In this section, the presentation will be rather general and it starts with a short overview of the history of the ABP, which is based upon van Klinken (van Klinken, 1967).

The first very small-scale pension regulations are mentioned in two publications of the government of the 'Bataafse Republiek' and are dated 1798. These grants were given by decision of the crown, were not conditional upon premium payment and were directly financed by the state budget. In the first half of the 19th century, various funds were erected for small groups in society; among these was the "Pensioenfonds ambtenaren tot de Rijksontvangsten". Due to insufficient - actuarial awareness, actuarial shortages rose steeply. In 1836, a fund for disability pensions was erected under the name "Algemeen Burgerlijk Pensioenfonds"[14]. From the beginning, the fund had an actuarial shortage, because of the inclusion of the actuarial shortages of its predecessor, the "Pensioenfonds Ambtenaren tot de Rijksontvangsten". Old age pension benefits again drew directly upon the state budget.

In the year 1846, the first order in council for the old age protection of civil servants was taken: the ABP was replaced by a so called Pension fund for civil employees or "Pensioenfonds voor Burgerlijke Ambtenaren", which did not only cover disability pensions, but old-age pensions as well. In order to prevent the newly erected ABP starting with a negative heritage, as its predecessor did, it was decided that only new civil servants, i.e. those who would enroll after that date, would become participants of the pension fund. The benefits of those who were civil servants before that date would again be paid out of tax receipts. It should be noted that these regulations included only civil servants of the state government. The Widows and Orphans pensions were not included in the 1846-

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[14] See van Klinken, 1967, p. 203: this fund was the first to cover all civil servants who where appointed by the crown and who where paid out of tax-receipts. Before that, namely from 1822 onward, there was a "pensioenfonds voor ambtenaren tot de rijksontvangsten", which covered only a very small group of civil servants.

law, this would have to wait until the Law on Civil Pensions or "burgerlijke pensioenwet" of 1890. In that year, the financial situation of the government was that bad, that the government decided to step down from the capital funding scheme for the disability- and old age pensions and return to a PAYG-scheme: the funds of the ABP were taken up to cover the state budget deficit. Of course, in the short term, these measures had effect, in the sense that the budget deficit of the following couple of years were lower. As could be expected, the situation worsened in the longer run, due to the heavy claims of old age - and disability pension benefits on the state budget. So, in 1922, the situation was more or less reversed when the pension law was accepted: as a result, the PAYG system was abolished in favour of the Capital Funding system: a pension fund (again called the ABP) was erected and a large number of regulations for civil servants of the local governments were unified with the state-government regulations. The government agreed upon paying annuities for the coverage of the pension claims of those civil servants who contributed to the PAYG-scheme in the past. The contribution was set at 15.5%. From 1933 onward, the ABP was no longer linked to the Ministry of Finance, but became the responsibility of the Minister of Social Affairs.

Due to various reasons (one of which being the decrease of the contribution rate from 15.5% to 14.5% in 1938, van Klinken, 1967, p. 213), actuarial shortages rose steeply from 1935 onward. The status quo was maintained until 1961, when the actuarial shortages reached a record of about 5 million guilders. The measures, taken by the government, among other things confirmed the adoption of the Capital Funding system and increased the contribution rate from its 1922 level of 16% to 21% and obliged the Minister of Social Affairs to immediately adjust the contribution rate to the development of the actuarial situation of the fund. In 1963, various measures by the Minister of Social Affairs among other things guaranteed the linkage between the various pension benefits and the development of wages and regulated the incorporation of the state pension AOW in the total pension benefit. In 1966, the pension law of 1922 was replaced by the ABP law or "ABP wet". This law confirmed the 1963 measures, as well as the direct responsibility of the Ministry of Social Affairs over the ABP, which include the premium-setting decision. In 1988, this ABP law was changed to loosen this link between the government and the ABP. Still, compared to other regular pension funds which were subject to the PSW and were controlled by the Insurance Chamber, the ABP remained an exception.

In 1993, the social partners decided to end the dominant role of the government in the ABP and to make the ABP subject to the PSW, as every other pension fund. In short, it was decided to make the ABP a private, self-administrating and independent pension fund from 1995 onward (ABP Annual Report, 1993, p.7). This decision was the direct result of the decision of the government, earlier that year, to fit the social security entitlements of civil servants in the regulations for employees in the private sector. This agreement by the social partners was more or less an outline of how the privatisation process should go and what the private ABP should look like. This outline was the point of departure for the formulation of a number of pension rules, by the executive committee of the ABP. These rules would in turn replace the ABP-law. The most important change concerned the premium setting method.

Before 1995, premiums were set exogenously by the Minister of Social Affairs. This meant that the development of the pension fund's liabilities were only to a limited extent reflected in the contribution rate. The development of the contribution rate is shown in figure 1.2. During the sixties and early seventies, this contribution rate remained stable. However, this changed in the late seventies, when a number of specific measures (the 'uitneemwetten') caused the contribution rate to decrease. Due to high real returns on investment, combined with rather low increases of the wage-rate, this was not a problem. It could however have become a problem in the future. In fact, in its annual report of 1990, the ABP argued that these "uitneemwetten", combined with other effects, would result in an actuarial shortage (ABP, Annual Report 1990, p. 8).

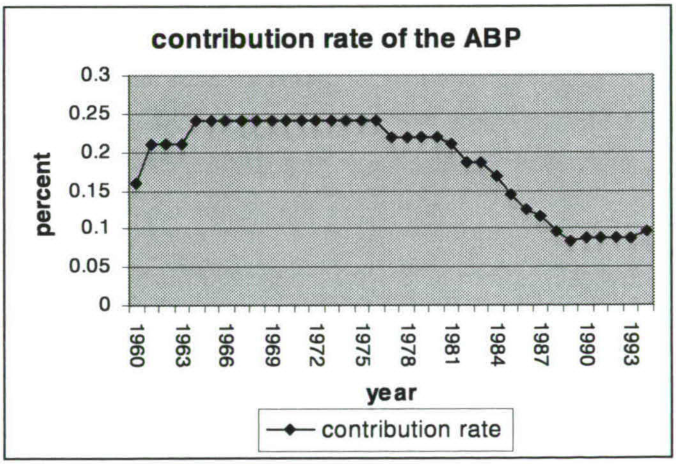

Figure 1.2: contribution rate.

From 1995 on, the ABP has accepted a so-called 'synthesis-premium'; a premium which combines both short- and long-term actuarial notions. This premium scheme will be discussed in depth later. In 1996, there were 878,000 active participants in the ABP, 264,000 old-age pension beneficiaries, 160,000 individuals receiving a Widows- Widowers and Orphans pension benefit and 86,000 disability pension beneficiaries. Thus, on the whole, there were 510,000 pension beneficaries. Moreover, there were about 714,000 inactive and non-retired participants: 41,000 of them receiving an early retirement benefit, 66,000 people eligible to a retaining pay and about 607,000 individuals with non-contributory pension claims (ABP, 1996). On the whole, more than 2 million people were, or had been, participating in the pension fund. The sum of benefits paid out amounts to about 7.6 billion guilders, while the ABP received about 4.2 billion guilders of contributions (ABP, 1996, p.10). In order to fulfill its tasks, the ABP had 2,375 employees on the payroll.

What benefits do ABP-beneficiaries get and what determines these benefits? The answer to these questions will be left for later. How are these benefits financed? The method of determining the contribution rate as used before 1995, can be characterised as being very simple at first - , but very vague at second sight. It is very simple at first sight, because the contribution rate was set by law each year, and the contributions were therefore exogenous to the ABP. These contributions made participants eligible to old-age pensions, disability pensions and widows/widowers pensions. As a result of the privatization process, the premium-setting mechanism changed profoundly. First of all, the APB no longer organized and financed disability pensions and the early retirement scheme, which finance scheme switches from being funded by interest receipts in the CF-scheme to an explicit PAYG-scheme. Secondly, a new contribution rate, called the synthesis-contribution rate was adopted. This contribution rate was no longer exogenous to the ABP itself and was formed as a weighted average of a long term premium, accompanied by a short term premium K. This will be considered in depth in the second part of this study.

In this first chapter, the Dutch system of additional pension schemes was presented and discussed. It started with outlining what funding methods there are. After that, an overview of the Dutch pension system was considered. Next, the second layer of this pension system, the whole of additional pension systems offered by pension funds, was discussed in more detail. In this paragraph, additional pension schemes as well as types of pension funds were classified. Lastly, the civil servants' pension funds ABP was discussed. This chapter provides information necessary to understand the problem definition, which will be developed in the second chapter.

Chapter 2: Intergenerational redistribution of income via pension funds: problem definition.

Introduction

In the previous chapter, the actual situation of the Dutch pension system was presented. The system of additional pension schemes as organized by pension funds was emphasized. In this chapter, a somewhat hidden characteristic of the system will be presented and discussed in depth. It will be argued that, contrary to what one could expect, it is possible and even likely that in a system of capital funding, any generation does not exactly cover its total pension claim. Some generations contribute too much, given their pension claim, and others too little. This implies that some generations partially cover the pension cost of other generations.

This chapter is composed as follows: in the first section, some definitions and notions necessary to get a clear insight in the matter, will be presented and explained. Here, the various redistributions of income will be explained. The main point of this crucial paragraph will be that there are two conditions for intergenerational redistribution of income to be inherent in a Capital Funding pension system. But even if these conditions are not met, intergenerational redistribution can occur, as a result of conscious actions of the funds' managers.

In the second paragraph, it will be considered whether or not the first of these conditions is met. For this, a closer look will be taken at how a typical pension fund sets the contribution rate using actuarial information of its participants: not just in theory, but merely in practice.

After that, the second condition for intergenerational redistribution will be dealt with in the third paragraph. Here, the demographic situation of the Netherlands will be highlighted.

In the last paragraph, an important variant designed to reduce the cost of the pension system for subsequent generations, will be presented and discussed.

2.1. Definitions and notions.

In this first paragraph, some definitions which are important for an understanding of the matter, will be given. The problem definition of this book concerns intergenerational redistribution of income It is therefore important to define and explain various forms of redistribution of income.

By 'redistribution of income', we mean that money is (consciously or unconsciously) indirectly transferred from one individual or group of individuals, to another individual or group of individuals. By the word 'indirectly' we mean that there is an organization (for instance, the government or, as it is in this case, pension funds) who willingly or unwillingly organizes the redistribution[15].

What forms of redistribution of income can be distinguished? First of all, there is horizontal income distribution. This is the solidarity between individuals who earn the same income, and involves the risk of insurance. One never knows exactly what age one will reach, if one will become disabled and so forth. The assumption that an individual makes expectation errors is quite accepted as the risk of insurance. Thus, from an ex-post point of view, some individuals contribute too much and others too little. Assume, however, that individuals' expectations are on average correct. This means that the total of funds generated (based on these expectations) would converge to the amount of funds which would have been generated in the absence of expectation errors. From the point of view of the individual, the risk involved with individual expectation errors at the age of death and other relevant variables is minimized. The existence of actuarial risk leads to <u>horizontal income redistribution</u>, that is the redistribution of income between participants who are alike with respect to income, age and so forth.

Now let us assume that individuals have knowledge of their age of death, but have unequal wealth. Suppose that, for some reason, these individuals agree with a flat benefit rate and an income related contribution. In that case, the rich individual covers part of the pension of the poor individual or, in other words, the lifetime income of the poor individual increases at the cost of the lifetime income of the rich individual. This solidarity is referred to as <u>vertical income redistribution</u>. Of course, the direction of this redistribution could also be the reverse, i.e. from the poor to the rich. Note as well that horizontal and vertical income redistribution are not necessarily mutually exclusive.

The third form of income substitution will be discussed in greater depth, since it is the core of the research subject. This is redistribution of income between generations. Before doing so, however, we should dwell for a brief moment on what is exactly meant by a generation. In this

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[15]A definition of a pension fund in the Dutch context can be found in WRR, 1999, p. 173. Here, a pension fund is defined as a non-profit organization which manages pension-savings on the basis of solidarity between the participants. Participation is compulsory and there is no competition in the market.

study, a generation is defined as being longitudinal in the sense that the year of birth of its members is the discerning factor. This is as opposed to the transversal definition of generation, where the age of the individual in a certain year is the discerning factor. Of course, both definitions are very strongly interlinked, and the difference will not always be very clear in the discussion to follow. This difference is that an individual remains in the same longitudinal generation for his or her entire life, whereas the transversal generation changes throughout his or her course of life. For a discussion in greater depth, see WRR (1999, paragraph 2.3, p 34).

Maybe the best way to explain intergenerational redistribution of income is by using a stylized (and even somewhat simplistic) example. Assume that we have a pension fund consisting of two individuals which belong to the same generation. Suppose that there exists a younger generation, in our example represented by two younger individuals who enter the labour force at the same moment that their two predecessors reach the age of 65 and consequently step out of the labour force. In the scenarios as described above, the 'pension-behaviour' of one generation is of no concern for the other generations, since each generation separately covers its own pension cost, with or without horizontal or vertical income substitution. The reason for this is the assumption that the expectations of the pension generating generation are on average correct, or, which is broader in definition, that every member of a generation <u>on average</u> generates his own pension.

Now what happens if, say, the older generation overestimates the real interest rate? In this case, this generation as a whole will underestimate the total amount of money needed to cover their pensions. This generation will therefore have underestimated the contribution which its participants should have paid while being young or middle-aged, and their pension will not be covered completely. In this case, the younger generation will carry the burden of this expectation error, since they will have to cover that part of the pension of their ancestors, which these did not cover themselves. Consequently, there will be an implicit transfer of annual income from the young to the old generation via the pension fund. We will see later that this is one of the conditions for <u>lifetime income redistribution between generations</u>, which means that the lifetime income of one generation (in this case, the older generation) increases at the cost of the lifetime income of another (the younger) generation. Again, intergenerational redistribution in the opposite direction is possible as well. If the older generation overestimated the amount of money needed to cover their pensions, the younger generation will have to contribute less than required.

The above definition is an oversimplification since the difference between annual and lifetime income redistribution must be made. Ermisch (Ermisch., 1989, p.19) defines intergenerational income redistribution as the situation where "*an age group consumes more or less than its labour income*". This is a rather general definition which is more general, as it is applicable for annual - as well as lifetime-redistribution between age groups. If an age group consumes less than its labour income *in a certain period of time*, which means that this age group is a net saver, then annual income redistribution does take place with one or more other age groups, which are net consumers. Likewise, if an age group consumes more than its labour income, where both are defined *over the lifespan of that age group*, then lifetime income redistribution between generations does take place.

It is important to realize that annual income flows between generations does not necessarily imply intergenerational redistribution of income. In fact, the effect of intergenerational redistributional income flows on the lifetime income of an individual can be interpreted as the balance entry of incoming and outgoing annually redistributive income flows. Ermisch (Johnson et.al, idem) points out that, given a constant age distribution or a stable population, "*all generations would experience the same net transfers at each age*", which means that there would be no intergenerational redistribution of lifetime income. Let us see why this is. The existence of annual income flows between (transversal) generations in the case of a CF-pension scheme can be seen as a PAYG-scheme 'hiding' in the CF-scheme[16]. This makes the explanation more straightforward. Now suppose that all generations are of the same size. In this case, every (longitudinal) generation will transfer exactly the same amount of money to the preceding generation as it will receive from the succeeding generation. So, no generation will experience any profit or loss, when measured in lifetime-income, which is equivalent to saying that no generation will consume more than its lifetime income in the definition by Ermisch given above. So, even if a PAYG-scheme exists within the capital funding scheme, i.e. even if generations do not cover their full pension benefit, there will be no intergenerational redistribution of income if the population is stable and if every generation

[16]To see why this is, think back to the example given earlier. As the two retired participants have underestimated the contribution they should have made, the succceeding participants have in a certain year to contribute extra to cover for the difference. So, a part of what they contribute to the fund is directly transferred to these retired generations.

covers the same fraction of its pension benefit and therefore leaves the same fraction to the succeeding generation. In this case, all redistribution will be between generations in the transversal sense of the word, but as lifetime incomes will not change, there will be no redistribution of income between generations in the longitudinal sense of the word.

This last condition is the most simple, so it will be dealt with first. Suppose that a generation leaves a part of its pension benefit to be financed by the succeeding generation, whereas that succeeding generation does not shift the same fraction to the generations to follow. In this case, not every generation covers the same fraction of its pension income, with the result that intergenerational (i.e. lifetime) redistribution of income will occur, irrespective of whether or not the population is stable.

Whether or not intergenerational redistribution (between longitudinal generations) occurs, is therefore subject to two conditions. The first is that one or more generations do not cover their own pension benefit. In this case, transfers of annual income between (transversal) generations occur. For annual redistribution of income to result in intergenerational redistribution of income, the second condition is that the population is not stable. In the next paragraph 2.2, it will be argued that the fact that generations do not cover their own pension benefit follows directly from the way in which the contribution rate is set in practice, for instance in the case of the ABP. In paragraph 2.3, it will be argued that the second condition for intergenerational redistribution of income to occur, an unstable population, is met for the Netherlands as well.

When analyzing intergenerational redistributive effects of pension systems, it is preferable to look at the lifetime income flows. The effect of intergenerational redistributive income flows on the lifetime income of an individual can be interpreted as the balance entry of incoming and outgoing annually redistributive income flows. This way, purely age-specific income differentials are eliminated[17].Consequently, these redistributive lifetime-income flows are generally smaller than what would be suggested by looking at annual redistribution flows (Creedy, 1991, idem, 1999), which is empirically confirmed by a.o. Nelissen (Nelissen, 1998b, p.13). But even if we are not so much interested in intergenerational redistribution of income, but in income inequality in general,

[17] Creedy (Creedy, 1991, p. 46) puts it as follows: "*only if all indivduals' earnings remain constant from period to period will a measure of inequality give the same results irrespective of the length of the accounting period*".

a number of authors argue that it is preferable to consider lifetime income inequality than annual income inequality (Harding, 1993, chapter 6, Nelissen, 1996 (b), Nelissen, 1998 (b), Creedy, 1991, Creedy, 1999), since the former is generally less unequal than the latter and since it is not affected by the situation which the individual is in in a certain period of time. But there is also a drawback, of course. Ermisch refers to the intergenererational lifetime redistribution patterns as "*while they are probably more interesting, they are almost impossible to measure*" (Johnson et.al., 1989, p.19). If this would be the case, this research would be a 'mission impossible', since this measurement is exactly what this whole study aims at and the measurement problem will be dealt with in paragraph 2 of the third chapter.

In this first paragraph of the second chapter, two conditions for intergenerational redistribution of income to occur were presented. In the next two paragraphs, it will be considered whether these conditions are met in practice.

2.2. The first condition for intergenerational redistribution of income: how is the contribution rate set in practice?

In this section, the way a pension fund sets the contribution rate will be discussed. In order to give an insight into why and how the actual pension contribution rate does not fully reflect the individual characteristics of the contributing participants, the point of departure will be the theoretical individual methods wich can be used to cover a pension claim. It will then be shown that the contribution rate which the pension funds set is usually based on either one of these theoretical setting methods, with that difference that general information on the group of participants as a whole is used. As a result, the contribution rate no longer meets the demands of actuarial fairness. This part of the text draws heavily on Roodbol (Roodbol, 1990) and Hilbrand (Hilbrand, 1990).

Of the various pension systems which were presented in section 2 of chapter 2, defined benefit systems -be it the final-wage system, the average wage system or the fixed amount system, all have in common that a certain pension claim for one or more participants is set. This future claim must be covered by contribution payments. In other words, the future pension claim determines the contribution, and not the other way around, as is the case with the available premium system.

In the case of wage-related pension systems, the pension claim depends on the wage which participants earn (sic). Let us start by presenting the system of constant annual premiums. This is the individual funding method which forms the actuarial basis for the way in which pension funds like the ABP base their contribution rate. Next, the difference with the way in which contributions are set in practice will be highlighted.

In the system of constant annual premiums, a constant (or age-independent) contribution rate is set such that the sum of the discounted future values of the contribution payments of an individual equals the expected discounted value of the benefits - referred to as the pension cost- taking mortality rates and a certain return on investment into account. As the name suggests, the most striking characteristic of this contribution rate is, that the contribution rate which an individual (or an age-group) faces, is independent of the age of this individual or the average age of the group, given a constant pension cost.

The above system to determine the contribution rate is explained on the basis of one individual or a group of individuals of the same age and income. Of course, this does not mean that these methods are necessarily only applied on the individual level. In practice, pension funds do not determine the individual future pension cost and the contribution rate this individual faces to cover this cost. There are at least three major differences between the various theoretical funding systems and the way in which pension funds form the contribution rate in real life. These differences are discussed now.

The first difference is that the pension cost is determined for all participants together, so that individuals cover a pension-wide average individual pension cost. This means that the contribution rate is set independent of the age of an individual and is an average contribution rate, a.o. based on the age distribution of the group of contributing participants. The second difference is that fund-wide expectations of the development of the pension funds' population and a number of exogenous developments are taken into account and even anticipated, in which case the system is said to be 'dynamic'. The continuation premium or "doorsneepremie", is a pension fund-wide version of the system of constant annual premiums (Petersen, 1990, appendix E, pp. 227-229) is most commonly used, often taking expectations into account. Kleynen (Kleynen, 1996, p. 40) calls this the 'going concern method'. The WRR (1999, p 184) refers to it as the (dynamic) liability-asset-contribution rate ("lasten-batenpremie) and states that this system applies to about 96% of the participants in the Netherlands.

So, the pension fund first determines how much assets it should have to cover the sum of future pension benefits, given an expected rate of return on assets (the discount rate). The difference between these 'required assets' and the actual assets has to be covered by current and future contributions, which should be the same fraction of the wage. The continuation premium is therefore equal to the difference between required and actual assets, divided by the discounted sum of current and future wages.

The result of the differences just presented is that every participant has to contribute the same fraction of his income to the pension fund. First of all, this makes the contribution-setting process more easy and clear-cut and avoids the pension funds having to keep an even greater record of individual information as they do today. Secondly, this avoids having to hire a massive staff of public relations-managers whose only task it would be to explain to individual contributors why their contribution rate is higher than that of the 'Joneses', using actuarial arguments which are uninteresting and irrelevant for these individuals. Thirdly, and most important, it allows for solidarity among the contributors in terms of coverage of an increase of the wage-base. All age groups pay the same contribution rate to cover an increase of the pension claims. Let us dwell upon this, because it is exactly this solidarity which causes every generation not to cover its own pension claim, which -as argued in the preceding paragraph- is one of the conditions for intergenerational redistribution of (lifetime) income to occur.

Suppose that the future pension benefit of all participants increases as a result of an unexpected increase in the wage-base. Suppose furthermore that the fund sets an age-dependent contribution rate based on the system of constant annual premiums. Remember that the backservice involved in such an increase in the wage-base is caused by the fact that the pension benefit is set as if the individual has been experiencing the new (higher) wage from the beginning of his or her career on. So, given a certain uniform increase of the wage-base, the backservice costs for older participants will be higher than for younger participants, since the former ceteris paribus have a longer career than the latter. Moreover, older participants would also have less years to cover the cost involved with this extra pension benefit.

As a consequence of these two effects, the age-dependent contribution rate should be higher for older active participants, since older participants would not only have a higher backservice, but would also have less years to cover the cost involved with this extra pension benefit. The contribution rate should therefore increase by age and it could therefore even be possible that it becomes higher than 100%, which is of course unacceptable. So, a certain contribution rate - the continuation premium, which is an average of the fictitious contribution rates of the young and old participants- is set.

Apart from limiting the changes of this 'doom scenario' of a contribution rate higher than 100%, using a method which determines an age-independent contribution rate allows the contribution rate to be rather continuous over time, thereby avoiding significant changes over time of the available income position of the participants.

The advantage that the funding of shortages is spread over as many years as possible is that the contribution rate is stable, but it also incorporates a risk: a part of the funding effort is shifted to an uncertain future[18]. This could imply that birth cohorts which cause a funding shortage shift the cost of this shortage to the future, which means that it will to a certain extent be covered by succeeding birth cohorts. In other words, annual income flows between generations will be the result.

This paragraph started with a description of the system of constant annual premiums, which is a system in which the contribution rate of an individual is intertemporally the most stable. Due to various reasons, pension funds such as the ABP usually set a fund-wide continuation premium, a uniform contribution rate for the whole group of active participants in the fund. The consequence of a uniform contribution rate is that the link between the individual premium setting systems and the uniform contribution rate is not very close.

The fact that pension funds use a continuation premium means that the first condition for intergenerational redistribution of income to occur, is met: generations do not exactly cover their pension benefit. As a result of the continuation premium, some costs (or benefits) involved in a change in the wage are shifted to the future. In the next paragraph, we will explore whether or not the second condition, an unstable population, is met. More specifically, the effect of demographic ageing will be considered in more detail, after which ageing in the Netherlands is considered.

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[18] It should be mentioned that, if a pension fund wants to minimize the time that it faces a funding shortage, it can adopt a contribution rate which is a weighted average of long-term notions, as emerge in the continuation premium, and short term notions. This is the strategy which the civil servants' pension fund ABP has adopted.

2.3. The second condition for intergenerational redistribution of income: ageing.

2.3.1. The effect of ageing.

In paragraph 2.2 , it has been argued that the pension claim of a certain generation to a pension fund is not necessarily fully covered by that same generation: the first condition for intergenerational redistribution of (lifetime) income to exist, was therefore met. To put it differently, in these cases, the capital funding system as used by pension funds incorporates implicitly some Pay-As-You-Go elements (Kuné, 1992(b), p.330), in which annual income is redistributed between generations. But by itself, this is no reason for intergenerational redistribution of lifetime income, as was argued in paragraph 2.1. If all generations are of the same size, then the outgoing annual figures would balance the incoming figures, so that no intergenerational redistribution of lifetime income would take place. In other words, part of a pension claim of a certain generation would be covered by a subsequent generation, whose pension claim in turn would be partly covered by the following generation, and so forth. This way, the pension claims of all generations are indirectly protected by younger generations, since unanticipated increases in the pension cost are partly shifted to the future. However, as every generation is of the same size, no generation would gain or lose in terms of lifetime income. The reasoning behind this is very simple: intergenerational redistribution of income means that the cost of funding a certain generation is shifted to the following generations. As this following generation is relatively smaller, *the part of the pension cost which any individual of the younger generation has to cover increases.* In other words, in this case, the pension cost for an individual of the younger generation will increase whereas his or her expected pension benefit remains the same: the pension therefore becomes more expensive.

The existence of intergenerational solidarity in the case of ageing therefore causes the contribution rate for younger generations to increase. This is the case given a certain constant pension cost for all generations. But this is not the only effect which ageing has on intergenerational redistribution of income. It will be argued next that ageing has other effects, which cause intergenerational redistribution of income -if it exists- to become more important over time. These effects boil down to, first of all, an increasing pension cost, irrespective of whether intergeneratonal solidarity exists or not and, secondly, an increasingly large relative part of this cost which is shifted to the future, and therefore to future generations. This means that there is a self-enforcing effect: as a result of ageing, the pension cost of all generations increases. In the case of a continuation premium, the part of the pension cost which is shifted to the future, increases as well.

But why would the pension cost of all generations in a pension fund increase as a result of ageing? What is the effect of ageing on the pension cost in the case of a Capital Funding system? The effects of ageing on CF pension schemes is twofold. First there is the direct effect and second, there is the effect of ageing on the economy as a whole and therefore also on the performance of CF pensions.

The direct effect of ageing is caused by the fact that that the average age of the pension funds' participants increase. As explained earlier, this means that the backservice involved with a certain wage change, increases, since the average length of career increases. Moreover, the average years to cover this increased backservice decreases. As those effects work in the same direction, their effect on the pension cost can be substantial. In an earlier study, Dekkers (1994(b), appendix II) showed mathematically that both effects, if persistent, can result in a very strong increase of the actuarially-equal contribution rate.

Unfortunately, this direct effect of ageing as described are not the only ways in which ageing affects the pension cost; the third effect is through the effect of ageing on the economy as a whole, which will be discussed briefly. For an extensive discussion of the effect of ageing see a.o. Jackson (Jackson, 1998, p.14 and chapter 3) and Lesthaeghe, et.al., (Lesthaeghe et.al, 1998), Miles (1999), Fougère and Mérette (1999) and McMorrow and Roeger (1999). Without going into detail, it can be said that ageing changes the prices of labour and capital in a way which is not positive for a pension fund. As a result of ageing, the size of the labour force will decrease relative to the population size. So, the productivity of labour will increase with the result that the wages will increase more sharply than before. This in turn will have an effect on the development of the pension claim. Analogous to this, the size of the capital stock will increase relative to the number of employed individuals, with the result that the productivity of labour will decrease. The demand for capital will then decrease, resulting in a lower interest rate. This last effect is particularly important for pension funds. Another line of reasoning which leads to the same result departs from the saving-perspective. According to the life-cycle hypothesis, households save in their active stage of life and dissave afterwards. When the population ages, the number of pension recipients increases relative to the number of pension-contributors. As a consequence, pension funds will start to dissave, for instance by selling stocks and bonds. According to Kotlikoff, this is "*one of the wammies in the double whammy young people are facing*" (Demsetz et.al. 1996, p.1). The result of this will be that the supply of capital will increase, with the result that the price of capital, the real rate of interest, decreases.

Now, as said earlier, these effects are not a cause for intergenerational substitution of income in itself, as long as every generation covers its own pension benefit so that no annual intergenerational redistribution of income occurs. Likewise, annual intergenerational income flows by themselves are not a problem either because, given a constant population distribution, these annual redistribution flows cancel each other out, so there is no intergenerational redistribution of lifetime income. *It is the simultaneous occurrence of ageing and the existing of annual income flows between generations which causes intergenerational redistribution of lifetime income.*

It was argued earlier that ageing is one of the conditions for intergenerational redistribution of lifetime income to occur. In this paragraph, it was argued that ageing can have a significant positive effect on the contribution rate of a pension fund and can drastically increase the cost involved with intergenerational solidarity. This automatically leads to questioning whether or not this second condition is met in practice. What rate of ageing do the Dutch pension funds face?

2.3.2. Ageing in the Netherlands.

As in most developed countries, especially in Europe, the growth rate of the Dutch population is declining and might even become negative at the end of the first quarter of the next century. This decrease in the growth rate implies that the proportion of the old in the population as a whole increases. This can be seen by looking at figure 2.1, representing the historical development of the Dutch population from the beginning of the century up to 2050, using the so-called 'Global Competition'-scenario of 1996[19].

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[19] See CBS & CPB, 1997. In this study, three scenarios are described. These scenarios are 'Divided Europe', 'Global Competition' and 'European Coordination'. The Global Competition scenario is characterized by a strong role of the market mechanism, high economic growth, a less important role for the welfare state and a restrictive immigration policy. The development population lies between the prognosis given the other scenarios and is very close to the (most likely) middle variant of the latest CSB-

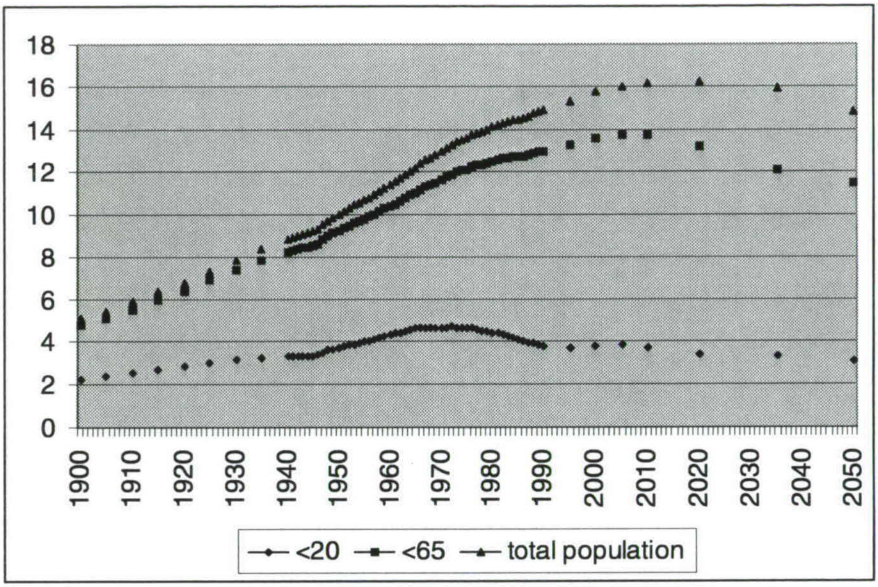

Figure 2.1: The horizontal axis denotes years, the vertical exis denotes millions of people. Source: CBS, *90 jaar statistiek in Tijdreeksen*, and *Bevolkingsprognose Nederland 1988-2050*, Maandstatistiek Bevolking 1988, no 12, p. 51.

The development of the population of a country can be explained by four variables: birth, death (or, which is inversely related, life expectancy), immigration and emigration. In what follows, the development of the first two will be considered, as they are the most important determinants of population growth.

From the beginning of the century until 1965, the Dutch population increased by 1.5 to 2 percent per year, the reason being mainly the decreasing mortality rate. In that period, the life expectancy at birth increased from 51 and 53 years for men and women in 1900 to 63 and 67 years respectively at the outbreak of the Second World War (WRR, 1992, p.38). During the war, the life increased gradually. Except during the war, life expectancy has increased smoothly and gradually during this century. In 1994, the life expectancy was 75.4 for males and 80.3 for females.

The development of fertility shows much more discontinuities than the development of the

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population prognosis of 1996. See also de Beer and Beetsma (1999), Beetsma et.al (2000).

life expectancy. The Total Fertility Rate[20] decreased gradually from 4.45 in 1900 to 2.96 at the end of the second world war. However, the positive effect of increasing life-expectancy on the growth rate of the population was by far the strongest. In the years after the second world war, the growth rate of the population increased as a result of a discontinuous and significant increase of the birth rate. This discontinuity is often called the 'baby-boom'. As a result, the proportion of the young in the Dutch population increased significantly, as can be seen from the figure. But things did not remain that way. The second discontinuity emerged between 1970 and 1975, but this time it was in the opposite direction: in 1975, the Total Fertility Rate had decreased to only 1.66, a dramatically low figure. This effect came down in history as the 'baby-bust' as opposed to the baby-boom.

The effect of these demographic trends on the development of the population is shown in figure 2.1. on the previous page. The population grows rather smoothly until the end of World War II. It then increases somewhat, due to a sudden increase in the birth rate. This, together with the lower life expectancy during the war, caused the proportion of the young in the total population to increase. This 'fertility jump' turned out not to be persistent, and the proportion of the young therefore returned to its old level. During the beginning of the seventies, the birth rate decreased dramatically. This time, the shift was persistent and this caused the proportion of the young to decline as the members of the babyboom-generation reached the age of 20. In the long term, the lower fertility rate results in a decrease of the growth rate.

Given this situation, what is the expected development of the Dutch population in the first half of the next century? To answer this question, the so-called 'Global Competition'-scenario of the joint projections of the Dutch National Bureau of Statistics and the Central Planning Agency will be discussed[21]. In this scenario, the Total Fertility Rate is assumed to be 1.7, the life-expectancy is expected to increase faster than it has been doing for the last 25 years and annual net immigration will be on the same level as the last 20 years, namely 30,000 individuals. The resulting development of the population is reflected in figure 2.1, namely the part from 1995 onward. It clearly shows that

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[20] Wetenschappelijke Raad voor het Regeringsbeleid (WRR), 1993, table 2.2. The TFR is the average number of children of a woman under the assumption that the fertility figures as well as the life-expectancy for women of that year remain unchanged.

[21] Note that figure 2.1 is meant only as an illustration. It is based on a more outdated prognosis of the Dutch population.

the population will continue to increase, but this increase will gradually slow down and become zero around 2020. The population will then have reached its maximum of about 16.9 billion people. After this, it will start to decrease. The figure clearly shows that the growth rate of the population is to a certain extent driven by the babyboom generation; at first, from 1946 onwards, the size of the youngest age group (younger than 20) increases relative to other age groups. As time goes by and more and more members of the babyboom-generation reach the age of 20, the relative size of the youngest age group decreases at the cost of the second age group and so forth[22]. Likewise, the positive effect of the babyboom on the population growth, being very strong at first, declines as more of the baby boomers decease. Between 2020 and 2030, the first members of the babyboom-generation will reach the age of their life expectancy, and as the members of this generation decease, the size population will decrease. The rate of greying, being the number of individuals older than 65 as a fraction of the rest of the population, will increase from 21.2% in 1995, via 24.9% in 2010 to a maximum of a about 43.6% in 2050[23].

In paragraph 2.1, it was argued that there are two conditions for intergenerational redistribution of lifetime income to occur. One condition is that solidarity between generations exists, in the sense that there exist annual income transfers between generations or, put differently, that generations cover part of the pension claim of other generations. It was argued in paragraph 2.2 that the way in which Capital Funding pension schemes are organized in practice implies that this condition is met. The second condition was that the population should not be stable. It was argued in this paragraph 2.3 that this condition is met as well. In the next paragraph, some variants designed to reduce intergenerational redistribution of income will be discussed. It is however questionable whether this will increase the welfare of the participants, as will be mentioned briefly.

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[22] This effect is sometimes described by referring to a piglet which is swallowed by a python: as the piglet is moving from the head to the tail of the snake, it is digested and therefore gradually becomes smaller (see Becker, 1994, p. 212, Lesthaeghe, et.al., 1998, p. 61).

[23] CBS&CPB, 1997, table 3.7, p. 40.

2.4. Variants designed to reduce intergenerational solidarity.

In the previous paragraphs of this chapter, it was argued that intergenerational redistribution of income is likely to occur. It is important to realize that intergenerational redistribution of income need not be a bad thing in itself. It was discussed earlier that the existence of intergenerational solidarity reduces the effect of changes of the pension claim to the annual contribution rate, and thus to the annual available income of participants. In other words, intergenerational solidarity keeps the development of the contribution rate over time as smooth as possible, thereby preventing large between-years changes of the available income of the participants[24]. But the most important argument is that a situation where intergenerational solidarity exists, could very well be optimal for risk-averse individuals (Ponds, 1995, WRR, 1999, paragraph 6.3), since this intergenerational solidarity reduces the risk associated with variables which affect generations as a whole - the long term real rate of return on investment, for instance.

Even if all participants would agree that the contribution rate should be set such that intergenerational solidarity is reduced to a minimum, underfunding might emerge unintentionally, namely as a result of expectation errors associated with various variables which determine the contribution rate, like the returns on invested funds. Petersen sees the level of the real rate of interest as one of the main risks that pension funds are subjected to (Petersen, 1992, p.148). Most pension funds use 4% as the standard rate of discount. This can be interpreted as being the expectation of the very long term rate of interest, since it is already 'reserved' in the (lower) premium which participants pay. The difference between the actual real rate of return and this 4% is used for, among other, the indexing of current pension benefits and the payment of transition costs (for instance those related to the equal rights of women in terms of pension claims) and overhead costs. So, this expectation 4% is a minimal required real rate of return, since it is already incorporated in the premium, and this expectation can be considered to be quite optimistic, especially in the long run (Kuné, 1992, Miles and Timmermann, 1999, Zalm, 1990). Lastly, as Zalm points out, pension funds tend to shift the actuarial disequilibria, mostly as a result of lower-than-expected investment returns, to the future (Zalm, 1990, p.13-16). As this catch-up was usually over a long term (mostly 10 years),

[24]The WRR (1999, p. 191) puts it in another way, by saying that the surplus value of a pension fund its that it makes the pension of the participants insensitive to the time horizon.

subsequent funding shortages added up, thereby causing intergenerational redistribution of income.

In the previous section, some arguments why intergenerational redistribution of income might not be a bad thing, were mentioned. However, intergenerational solidarity also incorporates a risk, since it causes the pension cost which a generation has to cover to be vulnerable to demographic changes as is the case with the PAYG-financing pensions. So, the cost of pensions for some generations could increase without this being reflected in an increase of the future pension claim of that same generation. As a consequence, this burden would inevitably be borne by other generations. It is questionable whether these generations would accept this burden. In other words: the distributional effects could jeopardise the whole system. This makes the future of the Dutch system of additional pensions uncertain, as is the case for the AOW: if generational imbalances were to occur, would future generations remain willing to contribute more and more to the system, even if their benefit does would not increase? Whether or not this would be the case has been the subject of theoretical research by Ponds (Ponds, 1995, chapter 3), and depends on, on the one hand, how risk-averse that generation is, i.e. how much they prefer a certain future pension outcome over an uncertain pension outcome, and on the other hand, how much that generation loses in terms of lifetime income, i.e. how much it costs to reduce the generation-specific risk. Of course, a pension fund cannot change the degree to which active population is risk averse, but it can try to influence the importance of intergenerational redistribution of income. In the remainder of this paragraph, some ways in which intergenerational redistribution can be limited will be discussed.

The most important driving factor behind the cost-increasing effect of ageing is the backservice associated with increases of the wage-base. Higher wages (for instance as a result of a shortage on the labour market) lead to a higher backservice (as the average number of length of a ongoing career of active participants increase) and must be covered by contributions in less time (as the average number of years between the age of the employee and 65 decreases). The high costs of the backservice is a direct result of the fact that the pension claim depends on the final wage. As was discussed earlier, in the final wage system, the relation between contributions and (future) pension claims is rather loose. Pension claims are a function of the wage which an individual earns in the last couple of years of his career, whereas the sum of contributions is in fact a function of the average wage. One possible way to overcome this, is by transiting the pension system from a defined benefit scheme towards a defined contribution scheme. In other words, the final wage scheme should then be replaced by an available premium system, in which case the (future) pension outcome should depend directly on the contributions made by the individual. Another less drastic way in which the burden of the backservice can be limited is by shifting from a final wage scheme to an average-wage scheme. This would strengthen the relation between contributions and pension outcome, since they would be a function of the same wage-base. The advantage of the average wage system over the available premium system would be that the pension benefits would remain guaranteed as a percentage of the wage-base, something which is more optimal if participants are risk-averse. The effect of changing various pension funds from a final wage system to an average wage system has been simulated in the context of a microsimulation model by Jansweijer (Jansweijer, 1996, p. 166), and the result is that the increase of contribution rate, as a result of ageing and in the base-variant - thus assuming that the current organisational and actuarial situation remains unchanged, would decrease by about 3 percent of the wage-sum, relative to the base-scenario. Over time, this difference would increase to about 6% after 2010 even tough the contribution rate would still increase. The same pattern is presented by Dekkers, Nelissen and Verbon (Dekkers et.al., 1995, table 3 variant 3). They also find that the premium remains about 3% below the premium in the base variant in 2000. In the longer run, this difference increases as well and becomes about 7% at most in 2045. So replacing the final-wage system by an average-wage system limits the cost-increasing effect of ageing on the pension scheme. But again, there is a drawback. Most individuals see their annual wage increase over their career: as a result, the average wage is mostly lower than the final wage. A shift from the final wage system to the average wage system could thus significantly worsen the (future) pension benefit which participants face. In the third part of this study, we will consider the effect of such a transition on the simulation results.

This ends the second chapter, which is crucial to the study as a whole. Here, the main point was that there are at least two conditions for intergenerational redistribution of income to occur. The first condition was that a pension fund uses a continuation premium which is the same for all active participants of all age -groups. The second condition was that the population should not be stable. In the second and third paragraph, it was argued that both conditions were met. The conclusion was that intergenerational redistribution most likely occurs within a pension scheme such as the one offered by the ABP. In the next chapter, the problem of how to measure intergenerational redistribution of income will be dealt with.

Chapter 3. Modelling and measuring intergenerational redistribution of income.

Introduction

In the second chapter, the reasons why intergenerational redistribution of income through additional capital-funding pension schemes is likely to exist, were presented and discussed. What has not been discussed yet, is how important this problem is in terms of amounts of guilders or how much it affects the lifetime income of individuals. Do the patterns described in chapter two emerge in reality? How much money is redistributed between generations? Which generations gain in terms of lifetime-income, and which generations lose? What is the expected effect of these patterns on the future contribution rate set by the pension funds? All these questions must be answered to get an idea of the (future) importance of the intergenerational solidarity.

From the discussion of the difference between intra- and intergenerational redistribution of lifetime-income, two problems emerged. First of all, we need to know the total redistribution of lifetime-income of individuals from various subsequent generations, as was argued in section 1 of chapter 2. This problem of measuring lifetime-income will be dealt with in the first paragraph. According to Creedy, "*any measure of overall redistribution would contain both inter-and intragenerational components*" (Creedy, et.al., 1993, p. 261), which need to be disentangled. The first paragraph will start by presenting the microsimulation technique and the characteristics, as well as advantages and disadvantages of this technique. After that, the Dutch dynamic microsimulation model NEDYMAS will be presented. Lastly, in the third paragraph, some specific considerations which must be taken into account when simulating lifetime income (and which should therefore be taken into account when interpreting the simulation results as well) will be presented and discussed.

3.1 How should intra- and intergenerational redistribution of income be measured?

When the goal is to measure intra- and intergenerational redistribution of income, the first problem is to measure lifetime income. A rough distinction when forming lifetime income redistribution is between ex-post and ex-ante redistribution. Ex post lifetime only takes the lifetime income of deceased individuals into account, for the lifetime income of individuals who are still living is by definition unobservable. The drawback of using ex-post lifetime information is, of course, that it is limited: first of all, panel data sets which cover a time span long enough to cover the lives of at least one generation whose members are all deceased are non-existent. The second drawback is that the information which can be obtained is antiquated, since the information of individuals currently living is ignored. Ex-ante income figures consist of the lifetime income of generations currently alive. So they do not have the same drawbacks as ex-post information, but the missing information on the future has to be 'touched up' with information coming from a certain expectation-formation process. This introduces uncertainty in the data.

The classic way in which the effect of policy variants on subsequent generations is visualized is via the governments' budget deficit (Auerbach et. al., 1992 and 1994, van de Ven, 1996, Demsetz et.al., 1996). This of course is a very rough macroeconomic determinant of the intergenerational redistribution of income. One of its main drawbacks is that it does not take microeconomic effects into account. For instance, revenue-neutral tax changes are ignored, whereas they can have very significant income effects. Moreover, as Auerbach et. al. point out, the budget deficit is not a well-defined economic concept, "*but rather an arbitrary number*"(Auerbach,et.al., 1994, p. 74). Moreover, "*a single deficit measure cannot identify the intergenerational redistribution of the burden of government finance*" (idem) and which neglects "*any implicit commitments the government has taken on*" (Dellis, Luth, forthcoming)

Given that we have individual or group-data on lifetime income -either actual data or generated by a model -, how can total redistribution through a pension fund -or any other social security scheme- be separated? The most straightforward method is used by Meyer and Wolff, for instance, who compare in- and outputs of a certain scheme (Meyer, Wolff, 1987), expressed in present values. "*The transfer component is then determined by comparing actual net pension benefits received by a sample of beneficiaries with what they would receive from an annuity purchased at retirement with compounded OAI contributions*" (Meyer, Wolff, idem, p. 260). For a certain group, the difference between the net receipts in both situations consists then of intragenerational redistribution and intergenerational redistribution. Meijer and Wolff disentangle the overall-redistributive and the insurance effect of an old-age insurance scheme. They do not, however, disentangle intra- and intergenerational redistribution of income.

This disentanglement problem can be avoided by transforming the data or model such that either one of the redistributional patterns is neutralized. Here, there are two possibilities: either intragenerational - or intergenerational redistribution is neutralized.

An important step in the simulation of intergenerational redistribution was the development of the so-called 'Generational Accounts' or GAs[25]. In Generational Accounting, the net benefits from the government of various subsequent generations are compared. The line of reasoning is that higher future net receipts from the government for some or all current living generations must, via changing government debt, be borne by future generations. These GAs basically are the net present value of past and future resources net of contributions paid by members of a certain generation. If the GA of a certain generation as a whole is negative -which means that the present value of benefits exceed that of payments, the burden of this on subsequent generations follows from the government's intertemporal budget equation. In the case of our research project, one could think that GAs could be used to measure intergenerational redistribution of income through a pension scheme, without taking intra-generational income redistribution of income into account. This way, the problem of having to disentangle between intra- and intergenerational redistribution of income would be avoided. However, Dekkers (Dekkers, 2000), argues that this claim is at least a simplification of the facts, as opposed to claims made by other authors (for instance Takayama & Kitamura, 1999, and Raffelhuschen, 1999). But the most important reason why GAs have not been used, is that GAs can handle only collective goods of which the cost is covered by either tax receipts or debt creation (Buiter, 1995). Additional compulsory and capital funding pension systems do not affect the public debt, nor are they financed by tax receipts, which means GAs cannot be used here (Centraal Economisch Plan, 1997, p. 126), at least not without having to make the necessary but unrealistic assumption that the whole Dutch population participates in a pension fund, in this case the ABP.

How should we then disentangle intra- and intergenerational redistribution of income? It is important to dwell upon this question, since the answer to it shows the demands which the model which could be used should meet. Suppose that we know the distribution of lifetime income of various subsequent generations, both under the restriction of existence and absence of a certain policy variant, a social security scheme or -as is relevant in the context of this study- a pension fund. Then for each generation, we can compare the lifetime income distribution given the pension fund

[25] See Auerbach, et.al. 1992, idem, 1994, Boll, et.al., 1994, Demsetz et.al., 1999, Dekkers, forthcoming, and Dekkers, 1999.

with a defined benefit scheme with the lifetime income of the same generation, given that there is no pension fund or a pension fund with a defined contribution scheme. Nelissen (Nelissen, 1995) represents these redistributive patterns by taking the lifetime income of different cohorts in deciles, both with and without taking the pension scheme into account. If the mean lifetime income of a certain cohort increases when the net contribution is taken into account, there is clearly redistribution of participants of other generations towards individuals in this generation.

Given that we do not have ex-post information on lifetime income and the net-contribution to an additional CF-pension scheme, what kind of model do we need to simulate this data? First of all, we need a framework which is specific enough to be able to model the effects of under- or overfunding of pension claims on the level of specific age groups of participants. Second, we must be able to simulate the lifetime income of any (representative) participant of a certain generation or birth cohort, in order to determine the effects of these shortages on lifetime income. Third, we should be able to simulate lifetime incomes for members of different succeeding generations, in order to describe the intergenerational substitution of lifetime income. The last demand is that the model should be precise enough to be able to model different types of pension systems (either flexible or not), this in order to give the possibility to analyse the effect of a change of the pension system (for instance from a final wage to an average wage system) on the other research questions.

A technique which allows for the formation of total redistribution of lifetime income, using microeconomic data and modelling, is microsimulation. Microsimulation is more than just a technique; it is a general method of empirical modelling, which allows for the simulation of specific groups (which also includes age groups) through time, this in interaction with other groups and institutions[26]. This way, ex-ante simulations are based upon ex-post simulations in one consistent simulation technique. The concept of microsimulation and its practical use will be explained and discussed in depth in the next section. Basically, in the context of microsimulation, the difference between ex-ante and ex-post simulations becomes irrelevant as both the past and the future are simulated by the same model, and it is therefore possible to use ex-post methods for the reproduction

[26] This reveals that dynamic microsimulation is meant. The other type of microsimulation models, static microsimulation, is not taken into account here, as it does not fit our needs. For an elaborate discussion about both static and dynamic microsimulation and their pros and cons, the reader is referred to Dekkers (Dekkers, forthcoming(b)).

of intra-and intergenerational redistribution patterns in an ex-ante context.

3.2. Microsimulation.

Empirically-economic models can be subdivided according to the level on which they apply. First of all, there are macroeconomic models. These models simulate entire countries or even groups of countries. Secondly, there are mesoeconomic models wich concentrate on the simulation of one of more branches of industry within a country. The third category of models has emerged the most recently and take (groups of) individuals as the point of departure. The models in this category are called microsimulation models (MSM) or micro-analytic simulation models and usually aim at evaluating the effect of various social- and economic changes on the distribution of certain characteristics for different groups of individuals.

Orcutt (generally seen as the 'founding father' of MSM), Caldwell and Wertheimer define microsimulation models by highlighting the difference with other types of models:

"*Microsimulation models are more general than macroeconometric and interindustry models in that they contain one or more populations of microunits, such as individuals [...] instead of but a single case of each kind of unit*" (Orcutt et.al., 1976, p.10).

Krupp, who was involved in the construction of the German Sonderforschungsbereich 3 (Sfb3), puts it as follows:

"*Microsimulation is based on the fact that one uses knowledge about the behavior of persons or decision-making units to investigate how the simulation of a particular unit changes as a result of external influences or its behavior*" (Orcutt et.al. 1986, p.32).

Nelissen (Nelissen, 1993, p. 32) defines the basic idea behind microsimulation models as that, departing from a representative sample, each period, the relevant variables are adjusted (if necessary) in such a way that, at the end of that period, the database is a representative continuation of the sample .

The way in which microsimulation models works can best be explained by rephrasing it to a problem common in econometrics, namely that of missing data analysis. Suppose we have a cross-sectional set of data of *n* variables and *j* individuals at the future point $t+z$, $z>0$ can be considered as consisting completely of missings, as shown in the figure 3.1. Now microsimulation models can be seen as tools to fill in the missings of the datasets at the future point $t+1$ up to $t+z$. Standard textbook econometrics shows that missings can be filled in by two general methods: cold-deck imputation and hot-deck imputation (Kalton, 1983). The subdivision of microsimulation models in static and dynamic microsimulation models can be brought back to these two techniques.

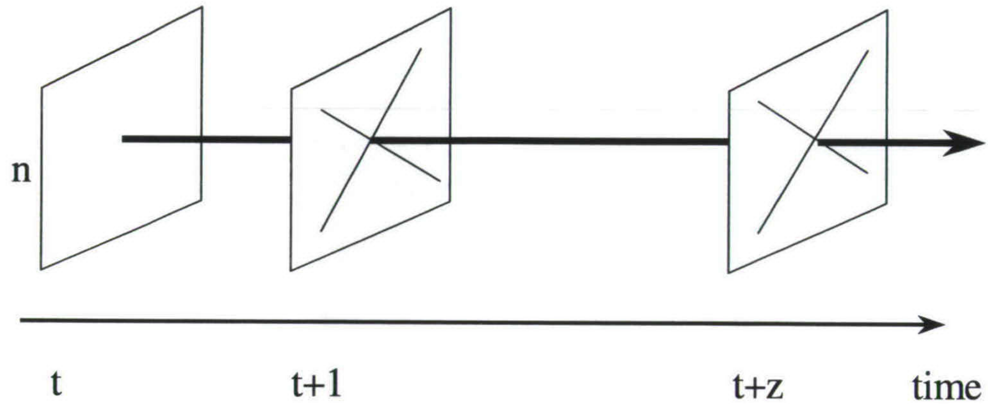

Figure 3.1.

Cold-deck imputation of missing variables forms the methodological basis of static microsimulation. The vast majority of cross-sectional datasets include a weighting variable which gives the individual more or less importance (i.e. a greater or smaller weight) in the sample, in order to make the sample more representative for the whole population, for instance by neutralizing the effect of selective nonresponse. The technique of static microsimulation boils down to adjusting these individual weights to let the dataset in the base year t meet the descriptions of the future population, which are exogenous to the model. Suppose, for instance, that a 1992-dataset consists of a certain percentage of women aged between 15 and 19 and suppose that we know from demographic projections that this proportion will decrease by 8.5% between 1992 and 2020. Then the '2020-proportion' of women can be formed by multiplying the weight variable of the women in this age group by (1-0.085)=0.915. Note that the weight variables of other categories must then be adjusted upwards in order to neutralize the effect of this decreasing proportion of young women on the weighted size of the sample as a whole.

By contrast, dynamic microsimulation fills in the missing datasets by using hot-deck imputation. Again, the cross-sectional dataset in time t, consisting of a number of individuals, each of which is described by n variables, is the point of departure. The adjustment of these variables is based on a set of equations, describing the individual behaviour of agents, and a decision process, based on the Monte Carlo procedure, which reflects the change in the (institutional) environment of the agent (if he remains alive, for example, or if he finds a job, as a second example). The simulations depart from a representative sample of individuals, all described by a number of demographic and economic variables. In a certain simulation year, every individual in that sample is subject to a number of possible changes of one or more of its characteristics. Some characteristics are determined by chance (for instance, every individual has, given his age, a certain probability of dying, in which case he drops out of the data set), with a certain probability, whereas others are static conditions (for instance, if an individual does not die in a certain year, his age is automatically increased by one). As said, individuals are described by demographic variables (gender, age, family circumstances, marital status) and socio-economic variables (health, size of labour, or social security income)

The basic difference between static- and dynamic microsimulation models is that the actual individual data remain unchanged in the case of static modelling; only the weight variable is altered corresponding to the future situation. In dynamic models, the weight variable remains unchanged, but the actual individual information is changed according to individual (exogenous) transition risks. The disadvantages of dynamic models are the advantages of static models, and vice versa. Static models are technically simple (though conceptually less intuitive than dynamic models) and by far less CPU-demanding. Moreover, given that the exogenous projection data exists of course, one can form the '2020-dataset' in one step, without having to simulate all the intermediate years first. This also reveals the most serious drawback of static microsimulation models in general (and a fatal flaw for this research subject): the fact that periods in time can be skipped reveals that static models do not have a 'memory'. This means that the situation in the future year 2010 does not influence the situation in 2020. Thus, in static microsimulation models, the future is fixed and each period is 'on its own': if there are backward-looking variables in the original dataset, they will be altered to meet the future situation, but unlike dynamic microsimulation models, static models can not create these variables. Why is this such a serious flaw for our research project? In the last paragraph 3.1, it was argued that intergenerational redistribution of income requires the measuring of lifetime-income. How is this done in a dynamic model, and could this be done in a static model? The lifetime income of an individual is formed by adding up the annual incomes of that individual for every year of his life. So, a new variable is formed in the year the individual is born and increased each year, until the individual deceases. Is this possible in a static model? No, simply because the individual does not get born, gets older or deceases in a static model. The individual data remains unchanged; only the weights change. Moreover, as said, the simulation results for a certain future year do not influence the simulation results of another future year. Consequently, the adding up of annual income- even if it would be meaningful- is impossible.

To recapitulate: are dynamic microsimulation models applicable for the answer to the questions stated in the introduction? Indeed they are, as it is possible to start modelling at the base: the individual. This means that lifetime incomes can be simulated and that groups of individuals can form pension funds of different types, in order to move income over the lifetime. This being the case, it must be possible to analyse the effect of disequilibria of the pension fund on lifetime income patterns of participants of different generations. It seems therefore optimal to construct a model which is micro-analytic by nature, and which therefore includes individual information but which is also capable of incorporating mesoeconomic elements (like a pension fund) and even macroeconomic elements, which is needed to determine the wage changes, the inflation rate and to simulate the effect of ageing on the economy. So, we need a microsimulation model which allows for interaction between groups of individuals (that is, a cross-sectional dynamic microsimulation model), which must be capable of deriving lifetime income patterns and must be able to incorporate macroeconomic information. The conclusion is therefore that a microsimulation model best fits these demands.

The main reason for the dynamic longitudinal microsimulation model NEDYMAS to be developed by Nelissen (Nelissen, 1993, Nelissen, 1994) was to analyse the effect of (different forms of) social security on the lifetime income of representative agents of different generations, and it was therefore necessary to build a entirely dynamic cross-sectional model, in order to be able to generate a representative economic biography of participants of different generations. NEDYMAS follows the general structure as described above quite closely; the recursive modules are demography, education, labour market and income formation and a social security module. One of the most important modules is the demographic module. Here, historical information on fertility rates, death probabilities and other key variables is combined with the information of the 'global-competition scenario', which was discussed in section 2.4. The social security module has as input the information from the other modules and consists of a number of probability- and conditional statements, reflecting the Dutch social security system. The simulations start with a representative sample of 10,000 individuals in 1947, each characterised by about 350 variables. As the simulation period ends in 2060, the lifetime income of the generations born in 1930 until around 1960 can be simulated.

3.3 Lifetime income.

When considering the simulated lifetime incomes which NEDYMAS generates, comprehension of what is going on could be improved by starting with recapitulating the definition of lifetime income. Of course, the lifetime income is in some way the summation of the annual incomes which the individual has gathered over his or her lifetime. But this does not mean just adding up the income which he or she receives at the age of 20 with the income at the age of 21 and so forth. By doing so, three relevant things would be ignored. These will be discussed in detail in the remainder of this chapter. First of all, the issue of discounting the data will be dealt with. Next, the way in which the data will be corrected for age-specific effects, cohort and period effects will be discussed. Lastly, equivalence scales will be presented.

First of all, annual incomes should be discounted. When forming lifetime income, annual income figures should in some way be aggregated. When doing so, it is not good enough to simply add up the incomes gathered over the various subsequent time periods. The reason is that risk-averse individuals prefer a certain amount of money today instead of tomorrow. Put differently, an individual is only indifferent between a certain sum of money today and a higher amount tomorrow. Expressing it the other way around, if two annual incomes must be compared or added up, they should first be discounted to a common year. Future sums of money are discounted downwards to a common year, whereas past sums of money are discounted upwards. In NEDYMAS, the annual incomes of all generations are discounted back or forward to the year 1992.

But knowing to which year to discount is not enough. The second decision concerns what discount rate to use. This decision is very important since it determines to a certain extent what kind of simulation results we get. For instance, assume a constant positive discount rate. This means that annual incomes received after 1992 decrease, whereas incomes before that year, increase. Moreover, if we consider two periods of time, both after 1992, the income which is received in the more distant future i.e. the further away from 1992, is discounted more. Likewise, if we compare two years before 1992, the income of the year which is further in the past (again the furthest away from 1992) is discounted upwards more strongly. What is the consequence of this? First of all, the lifetime income of generations alive mostly after 1992 is corrected downwards, whereas the lifetime income of generations before 1992 shifts upwards. But there is more: for a generation living after 1992, the benefit is further away from this year as the contribution. So, the benefit is discounted to a greater extent than the contribution, which means that the benefit decreases relative to the contribution. In the case of the generations before 1992, the opposite situation occurs. In this case, the contribution is further away from 1992, so that it is more heavily discounted. In other words, for these generations, the contributions increase relative to the benefits. In a number of studies, a fixed discount rate is used. This study is no exception, since a 2% discount rate is used. In his study on the redistribution effects of the Dutch social security system, Nelissen (Nelissen, 1994) uses a fixed discount rate of 2% as well. As a simulation variant, he also uses a discount rate of 3%. What is the effect of this 1% increase of the discount rate on the lifetime income of the four subsequent generations? For this, consider Nelissen, 1994, table 8.25 page 209. For the first two generations (i.e. 1930 and 1940), the lifetime income increases with no less than 16% and 12%, respectively. For the 1950-generation, the increase is 5%, which is smaller though considerable. It is only for the last generation that the period of life is for the larger part after 1992, which means that lifetime income decreases as a result of the increase of the discounting rate. The decrease is 3.1%. In another study, Nelissen (Nelissen, 1998(b), table 4 and 5, compares the lifetime coefficients of inequality (measured by the Theil-coefficient) for the cohorts 1930 and 1950 given discount rates ranging between 1 and 6 per cent. Departing from a discount rate of 4% and a per capita income growth of 2%, he concludes that "*other discount rates and income growth figures result in comparable* *outcomes.*" (Nelissen, 1998(b), p. 247).

The conclusion that the effect of the discount rate on the level of the lifetime income of some generations is important can safely be drawn. In other words, the simulation results which the model generates are to a certain extent determined by the particular discount rate. However, the effects of the various simulation variants are comparable with those of the base-variant, since they are simulated with the same discount rate.

Secondly, the simulation data should be corrected for various effects. According to Harding (Harding, 1993, p. 32) there are three different effects which are very difficult to disentangle for dynamic modellers. The effects of the first type are age-effects, which are changes that occur with the increasing age of individuals. One can think of the fact that young individuals contribute to a fund, whereas retired individuals receive a pension benefit. Secondly, there are cohort effects, which are the same for all individuals who belong to the same birth year or adjacent years. For instance, Berger mentions several cohort-effects on earnings, opportunities on the labour market, and so forth (Harding, 1993, Berger, 1985). The most well-known is that Easterlin argues that members of large cohorts ceteris paribus face higher unemployment rates, less favourable economic circumstances, and therefore lower lifetime incomes than members of smaller cohorts. The third type of effects are the period-effects. These are effects which affect all cohorts alive in a certain time period. Examples of period effects are wars, the great Depression and the oil crisis[27].

As it is the goal of this study to simulate the redistribution effect of a pension fund, the civil servants pension fund ABP, at least the age-specific effects and the period effects should be neutralized as much as possible. Cohort effects are not incorporated in NEDYMAS, so there is no need to neutralize them. The very fact that lifetime income is used instead of annual income implies that age effects are neutralized. But how about period effects? How can these be singled out? The answer to this question starts by noting that these effects are only relevant insofar as they affect the annual income of the individuals alive in a certain period. If we want to neutralize period effects, we are looking for effects which affect the annual incomes of all individuals alive in a certain period.

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[27]Note that this cancelling out of effects can also be interpreted so as to ensure as far as possible the longitudinal definition of a generation. By removing the age-effects, the defintion is neutralized for the transversal definition of generation. The second category of effects which are removed could loosely be interpreted as correcting for the 'Becker-definition' of generation (see Becker, 1992, WRR, 1999, paragraph 3.2), at least for those effects which are not implemented by the ABP itself.

The way in which this can be done is simply by deflating the annual incomes by the wage index. This has been done in the case of NEDYMAS as well.

We have now discounted the annual data, as well as corrected these results for period effects. Lastly, the question of whether or not individual or household income will be constructed will be used. When lifetime *individual* income is constructed, annual discounted values of income of an individual are aggregated over the years. It is however common practice when considering welfare in an empirical context, that individual incomes at a certain moment in time are added up to *household* income. This would mean that an income which an individual member of the household earns in a certain year, would add up to the lifetime of all other individuals in the household. So, children who live in the house of their parents would receive a part of their lifetime income from their parents and would later add to the lifetime income of their children as well. This study is an exception to this habit, for the calculation of the household income will be limited to those who in some way are linked to the ABP. This is the (ex-)civil servant and his or her partner. The income of the parents will therefore not be passed on to the children in the household. This has been done for several reasons, to be explained now. If the income of the elderly is 'passed on' to the children in the household, systematic income differences between generations are passed on as well, thereby 'blurring the picture'. It is for this reason that we can expect that differences in lifetime individual income will be larger than the differences in lifetime household income. This is the first argument. The second argument is that if equivalent income were also assigned to the children in the household, intergenerational redistribution of income as we measure it will not only be dampened but also be biased. To see why this is so, compare two situations. First of all, suppose that there is redistribution of income from a generation to a preceding generation, meaning that the profit which a certain generation gets out of the pension fund is covered by the loss of the succeeding generation. However, the preceding generation will pass on this profit to the succeeding generation, thereby partially neutralizing the effect of the intergenerational income redistribution. Secondly, suppose the opposite situation in which a generation gains at the expense of a succeeding generation: in this case, the neutralizing effect will be from adult children to their parents, if they live in the same household. The proportional number of parents who live in the same household as their adult children can be expected to be considerably lower than the proportional number of non-adult children who live in the same household as their parents. So, the neutralizing effect would be stronger in the first case than in the second case, meaning that the intergenerational redistribution of income from young to old generations would ceteris paribus be more important than vice versa. Of course, this effect will not be the most important in this study, since the above line of reasoning implicitly assumed that both parents and children participate in the same pension fund. Unfortunately, it gets worse: not only do we have a biased effect that intergenerational redistribution from young to old generations becomes stronger whereas the opposite effect becomes weaker, but the importance of this bias also changes over time, which is the third argument.

Suppose that the proportional number of civil servants to the labour force increases strongly over time. The result then is that the probability that children of civil servants become civil servants as well, increases[28]. As a result, the implicit assumption regarding two generations of civil servants in the same household as mentioned above, will more likely become true. The consequence of this is that earlier-mentioned bias becomes stronger over time. If the proportional number of civil servants decreases, the bias becomes smaller.

Of course, one could say that the importance of the last argument is limited, since the number of civil servants relative to the labour force is limited[29], but still, it adds up to the other arguments which were mentioned. A fourth and last argument for not including children in the construction of household income will be mentioned now.

This fourth argument is based on the fact that individuals live in various households throughout their lives. If they are in their active life, earning money and contributing to the pension fund, they often live in a household with children. As opposed to this, those individuals who are retired in some way and receive a pension benefit from the fund, more often have their children living in households of their own. This would not be a methodological problem, if it weren't for the fact that we are dealing here with a pension fund in which not all individuals participate. Only civil

[28] This effect is strenghened by the fact that children of better educated parents have a higher chance of becoming more highly educated themselves. Now the probability that one becomes a civil servant is higher for more highly educated individuals (and, by the way, very low educated individuals) as compared to other educational categories. Adding things up, the probability that a child of a civil servant (with a relatively high probability of having a high education) becomes a civil servant as well, becomes stronger than for other categories.

[29] The National Accounts Tables A13 and A15 for example show that the number of civil servants relative to the number of employees in the private sector increases from about 14% in 1970 to 19% during the eighties.

servants do. If 'full' households (i.e. where the income is also assigned to children in the household) were considered, children of civil servants who do not become civil servants themselves implicitly would have contributed to the pension fund but would not receive a pension benefit. This in turn would mean that more individuals contributed than received a benefit. Put differently, contributions would be more important than benefits in terms of lifetime income, depending on how household circumstances change over time. Now this bias changes over time as well, thereby making things worse again. Suppose that the fertility rate drops, thereby lowering the average number of children in a civil servant's household over time. This would mean that the bias which increases the importance of contributions relative to benefits would assume that earlier generations contributed more to the pension fund (measured in household lifetime income and assuming constant pension benefits) than later generations did, whereas in fact we would be looking at the effect of changing household-sizes.

But not forming 'classic' household income out of individual income (by assigning income to the children in the household as well), might be a smart thing to do for reasons just mentioned, it remains counterintuitive and unusual when dealing with anything even remotely associated with welfare economics. For we usually deal with utility of spending possibilities, rather than household income itself. So, apart from discounting, the household income must in some way be corrected for the household size, in which case the number of children is to be included. One can imagine that a certain income does not reflect the same spending possibilities for a one-person household than for a household of two adults and, say, four children. Likewise, given a certain amount of income, one can imagine that the spending possibilities of seven separate households would be less than that of one household consisting of seven individuals, due to scale effects such as housing. Household incomes should therefore be corrected for this difference. When doing so, it is however not good enough to simply divide the income by the number of individuals in the household. For instance, one can also imagine that a household consisting of five adults can consume less out of an income than a household of two adults and three children. A household income should be divided by a certain number, somewhere between zero and the number of individuals in the household. The theory of equivalence scales will not be discussed in detail (see Cowell and Mercader-Prats, 1999, for a discussion). Nor will an extensive overview of what different kind of equivalence scales there are, be given. In most studies, rather simple equivalence scales are used. For instance, the equivalence scale used in most studies of the European Commission -and therefore called the EU-scale, the weights attached to the head of the household, the spouse (or other adult individuals) and children are 1, .5 and .3 respectively[30]. By contrast, the OECD-scale is 1, .7 and .5. As said, these equivalence scales are rather crude: not only are they not based upon reported needs of individuals, but the age-composition of the household is not taken into account as well. It is for these reasons that the so-called 'empirical subjective method' is used in NEDYMAS. According to Nelissen (Nelissen, 1993, p. 15) "*these methods ask people what income is sufficient to live on themselves or for others. The answer can be related to household composition, the actual income, the average income of the household's reference group, and so on.*" This method of deriving equivalence scales, described in Kapteijn and others (Kapteijn, et.al., 1985) is based on the Subjective Poverty Line (SPL), where households are asked which income they need to reach a minimal level of welfare. As opposed to the above-mentioned EU- and OECD-scales, a couple without children is the point of departure. Examples of these household equivalence scales can be found in Kapteijn et.al, 1985 and Nelissen, 1995, table 1.4 p. 15.

Before turning to the exact way in which the ABP is modelled in the context of the dynamic microsimulation model NEDYMAS, let us reconsider what is meant by intergenerational redistribution of income one last time. In paragraph 2.1, various forms of income redistribution were defined. Lifetime income redistribution between generations was said to happen if the lifetime income of one generation increases at the cost of the lifetime income of an other generation. This implies a zero-sum-game where the positive and negative intergenerational redistribution flows cancel each other out. This would be the case in our model as well, if the fund was 'closed' in the sense that the whole world was participating and if the history of the fund would have been limited to the four generations under consideration. This is not the case, of course. The consequence is that there is no longer a zero-sum game. For instance, it could be that all four generations would increase their lifetime income at the expense of other generations which are not taken into account. It could also be that there is redistribution of income from non-participating individuals in some or all generations to participating generations. In both cases, the lifetime income of all generations under consideration increases. The fact that there are other generations which are not taken into account,

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[30]This is also known as the modified OECD-scale.

already suggests that the zero-sum game-requirement will not be met. For it is not realistic to assume that there are no financial transfers between the four generations under consideration and other adjacent generations, while knowing that these transfers exist between these four generations themselves. This means that there will inevitably be some unobserved intergenerational redistribution between the four generations under consideration, destroying the zero-sum-game requirement.

Moreover, we know that the pension fund invests the contributions and realizes a return on these investments. An expected real return on investment of 4% is reflected by the discount rate and is therefore already incorporated in the contribution rate. But if this expectation is not met, i.e. if the real rate of return is higher or lower than this 4% in the long run, then there is redistribution of income with the outside world, i.e. with those members of the various generations which are not participating in the pension fund. In the third part of this study, the lifetime-simulation results will be considered. It will be seen that, as a result of the rate of return being higher than the discount rate used by the fund, *every* generation under consideration gains from the pension fund. This means that there is no zero-sum game, in the sense that the gains and losses of the generations -corrected for the sizes of the generations- do not cancel each other out, which means that they do not reflect intergenerational redistribution of income.

So, there are two conceptual problems: first of all, as a result of the fact that the pension fund invests the contributions and realizes return on these investments. So, *every* generation gains, meaning that there is no zero-sum game. The second conceptual problem is that there will inevitably be some unobserved intergenerational redistribution between the four generations under consideration and the adjacent generations surrounding them, thereby again destroying the zero-sum-game requirement. Can these conceptual problems be solved, or at least overcome? The second one cannot, as we simply do not know how important these unobserved income flows between the four generations under consideration and other unobserved generations are. How can the first problem be overcome? Following a somewhat Rawlsian- or minimax-view on welfare, one could say that every generation should get the same per-guilder gain from the pension fund. So, by subtracting average per-guilder gain from the actual gain of every generation, a zero-sum-game would be imposed: any gain which a generation would get above this level would be 'covered' by an equivalent loss for other generations. Let us call this the 'above-average profit'. Of course, subtracting a constant per-guilder percentage from the total gains of the various generations does not alter the pattern of profits. It just ensures that 'above-normal' profits of some generations are neutralized by losses of other generations, among other things by imposing the assumption that all unobserved intergenerational redistribution adds equally to the gain (or loss) of the four generations under consideration. It is clear that this is a rather crude assumption, but it seems the safest thing to do, given that we do not have any information on this unobserved intergenerational redistribution. This way, the relative sizes of gains and losses become more emphasized. In other words, not the gain of a generation is shown, but the *gain relative to other generations* becomes visible.

To summarize, in the third part of this book, lifetime contributions and benefits from the ABP of the four generations under consideration will be presented and discussed. These simulation results however will imply that the zero-sum requirement is not met. Merely for illustrative purposes, these tables will therefore be accompanied by figures showing the positive or negative above-average profit of the four generations.

In this third paragraph of the third chapter, some issues concerning the way in which NEDYMAS constructs lifetime income were discussed. First of all, annual income figures, contributions and benefits should be discounted to a certain year, in order to make them comparable. Secondly, in order to neutralize period effects, these figures were also deflated with the wage index. Thirdly, instead of using individual lifetime income, we use lifetime household income, with this difference that income is not transferred to the children in the household. In the next chapter, the first part of this book will be summarized and an outline of the rest of the study will be given.

Chapter 4. Summary, Research problems and possible solutions and further outline of this book.

This book started with a description of the Dutch pension system, emphasizing its second level, the additional pension schemes, organized by pension funds. The first paragraph of chapter 1 was devoted to the discussion of some definitions. Here, the difference between Capital Funding (CF) and Pay-As-You-Go (PAYG) pension schemes was outlined. The second paragraph then described the Dutch pension system in broad lines, after which the third paragraph discussed the second layer of this pension system, consisting of additional CF-pension schemes of various types and offered by pension funds. The last and fourth paragraph of the first chapter then dwelt upon the largest of these pension funds; the civil servants' pension fund ABP.

The second chapter started with defining various forms of redistribution, the most important being redistribution of income between generations. This should be measured in terms of lifetime income instead of annual income. Moreover, it was argued that there are (at least) two conditions which should be met for this intergenerational redistribution of income to occur. The following two paragraphs where then devoted to discussing these conditions in more detail. In the second paragraph of the second chapter, it was argued that the way in which pension funds set their contribution rate in practice causes the first condition to be met. After that, the third paragraph discussed the demographic situation of the Netherlands, thereby showing that the second condition is met as well. The fourth paragraph lastly showed a way in which intergenerational redistribution of income could be limited.

The third chapter dealt with the question of how intergenerational redistribution of income should be simulated. The first paragraph dwelt upon lifetime income, thereby outlining what demands such a model should meet. The conclusion was that dynamic microsimulation was the type of model needed for the above-mentioned problem. In the second paragraph, microsimulation was discussed, and the Dutch microsimulation model NEDYMAS was presented. Lastly, the third paragraph considered some issues involved with the simulation of lifetime income in more detail.

The research problems which have been developed in this first part of the study are the following: is there income redistribution between generations through additional compulsory pension schemes? If so, what are the causes and directions of these intergenerational income flows, and what are the results in terms of lifetime income of members of different generations? The last question is what the possibilities for reducing income redistribution between generations are.

In the second part of this book, this pension-fund module will be presented and described, together with the interdependencies with the rest of the microsimulation model. In the third part, the basic simulation results (the base variant) will be presented and discussed in further simulations. After that, some simulation results will be presented and discussed using the results of the base variant as a benchmark. This will show the various causes of intergenerational redistribution of income, as well as their importance. The last part of this book will then contain the conclusion.

Part II:

Simulating the civil servants' pension fund ABP: a closer look at how the ABP is modelled.

Introduction.

In this part of the book, the pension fund model will be explained in more detail. How are various subcategories disentangled? How are various contribution rates set, and what actuarial model -if any- underlies these contribution rates? In particular the various actuarial models will be described in more detail. Some things will not be dealt with, however. One of the first questions which comes to mind when simulating the civil servants' pension fund, is "who becomes a civil servant and what do civil servants earn"? These questions -interesting as they are- are not within the scope of this book. Modules determining this are developed by Nelissen (Nelissen, 1994, Ch.6).

In the previous chapters, it was made clear that the pension system changed considerably in 1995, the year in which the ABP became privatised. Two modules are linked to the microsimulation model NEDYMAS, separately including the pre- and post-privatisation versions of the ABP. This second part consists of only one chapter, thereby emphasizing its importance. In this fifth chapter, these ABP-modules are described. Chapter 5 starts with a general description of the pension fund-model. Next, the module reflecting the way in which the ABP was before it was privatised, will be presented and discussed. Thirdly, of course, the module representing the privatised ABP will be discussed in length. In both cases, a great deal of attention will be given to the actuarial model underlying the base-rate premium (in the first module) and the actual contribution rate for old-age and Widows/Widowers- and Orphans pension benefits (from now on, 'Widows/Widowers and Orphans' is abbreviated to WW&O) in the second module. Chapter 5 will then conclude with describing two examples of modelling of a more ad-hoc nature. In this last paragraph, the way in which assets are modelled will be considered in particular.

chapter 5 : The civil servants' pension fund ABP.

Introduction.

In the first part of this study, the civil servants' pension fund ABP (being an abbreviation of Algemeen Burgerlijk Pensioenfonds) was presented, together with its history and current status. The way in which the contribution rate was set before and after 1995, the year in which the ABP became subject to the Pension and Savings Law (like other pension funds) was explained in general terms. In this chapter, the various modules designed to simulate the ABP and the way in which the contribution rates are set, will be discussed.

This chapter consists of three sections. In the first section, the general framework of both the pre- and post-1995 modules will be discussed, as the difference between both modules is predominantly reflected in the way in which the contribution rates are set. Before 1995, the contribution rate was exogenously set by law and therefore was independent of actuarial notions as experienced by the funds' managers. However, for 'internal use' there was an actuarial-contribution rate, based upon the information of the group of first-year participants or those who are civil servants now whereas they were not the year before. The way in which this hidden contribution rate is modelled will be discussed in section 2. The motivation for presenting it is that it gives way to presenting the general method of modelling actuarial calculations in a simpler and more comprehensive situation than is the case in the third section. Moreover, its simulation results provide a yardstick in its comparison with the actual pre-privatised contribution rate.

The way in which the actual contribution rate of the privatised ABP is set is presented in the third section. The exact formulation of the actuarial model underlying both the base-rate premium -before 1995- and the actual premium, are left to the appendix. In the main text and as far as possible, only the general formulations will be presented and discussed.

5.1. the civil servants' pension fund ABP: general outline of the pre- and post-privatisation modules.

The 'actuarial organisation' of the ABP before and after 1995 can best be explained with the help of figure 5.1. This figure 5.1 shows a flow chart of how the ABP-pension fund modules deals with the living individuals in the microsimulation model. It is via this flow chart that it is determined who receives what pension benefit, or contributes to the pension fund. Of course, it follows closely the way in which the different participants in the fund are disentangled in practice. So, apart from technical remarks of how things are simulated in the microsimulation model, one can also use the flow chart to gain knowledge of how the ABP itself disentangles the various types of participants. Every living individual in the microsimulation model passes trough this flow chart and naturally enters it in the upper-left corner. The first question is whether or not the individual under consideration had a partner or an ex-partner who is now deceased and who once was a civil servant. If this is the case, and if the individual (the surviving partner, so to say) is female then she becomes eligible to an WW&O-pension benefit. If the individual is however male, then he becomes eligible only from January 1st 1986 onward[31]. It is interesting to emphasize that the above decision chain to determine WW&O-pension beneficiaries is in this case in an opposite direction to that used by the ABP in practice. In the latter case, the file of all pension claimants (i.e. former civil servants) is considered. If a deceased claimant is found, then its family members potentially become eligible to an pension benefit. In the above flow chart, it is considered whether or not all living individuals were family of a deceased pension claimant, irrespective of whether or not they are civil servants themselves. The reason for doing this, is that it is less CPU-demanding, because it only requires the remainder of the dataset for every individual to be searched for, and not the complete set. For every individual who is alive, we check two times for a possible pension claimant, namely a deceased father or a deceased mother. If we would do it the other way around, not only should we start by

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[31] This is not entirely true: the group of potential WW&O-pension beneficiaries was extended to male surviving partners only in 1989. It was then decided that for this group, the benefit would be paid out as if the beneficiary was entitled to a pension one year before he actually applied for one. This 'backward-correction' went back to 1986. In other words, even though the extention only took place in 1989 and the benefits for these male beneficiciaries were paid out only then, the claims were derived as if the extention was implemented from 1986 on (ABP, Annual Report 1990, p. 20).

having to consider all deceased individuals in the database if they were once a civil servants, but we would have to look for all (living) family members of these deceased civil servants. It is clear that this is a much more difficult and, especially, CPU-consuming way of modelling.

The other states which the individual can be in with respect to the pension fund, are independent of whether or not one is eligible to a WW&O-pension scheme. This is reflected by the dark downward-pointing arrows: every individual is considered for his or her eligibility to a WW&O-pension benefit, as well as any other pension benefit. Next, if the individual is older than 65 and has been building up a pension claim in the past, he or she is eligible for an old-age pension benefit of at least zero guilders (if one never earned more than the exemption). If the individual is younger than the retirement age and a civil servant, then he or she is an active participant in the pension fund, who contributes to the fund and who is building up a future pension. The total number of active participants in a certain year is therefore determined by information coming from the demographic module and the macroeconomic labour demand of the government, as derived in the macroeconomic labour equation which will be presented in paragraph 5.4. It is also possible that one is younger than the retirement age, but not an active participant. In that case, there are three possibilities. It is possible that one is disabled: if one has been building up a pension claim in the past and then becomes disabled while being a civil servant, one becomes eligible for a disability pension. Next, if a former civil servant enrolls in an early retirement scheme, he or she becomes eligible for an early retirement benefit. Lastly, it is possible that one is in neither one of the situations mentioned, but still has been building up a pension claim in the past. In that case, one is referred to as a 'person with a non-contributory pension claim' or, literally translated, a ‘sleeper’. Lastly, it is also possible that one has been laid off by the government sector, like non-contributing participants, but that one (still) is eligible for a (limited) retainment pay benefit or 'wachtgeldregeling', which is a specific unemployment benefit for former civil servants. In this case, one is referred to as a retainment pay beneficiary.

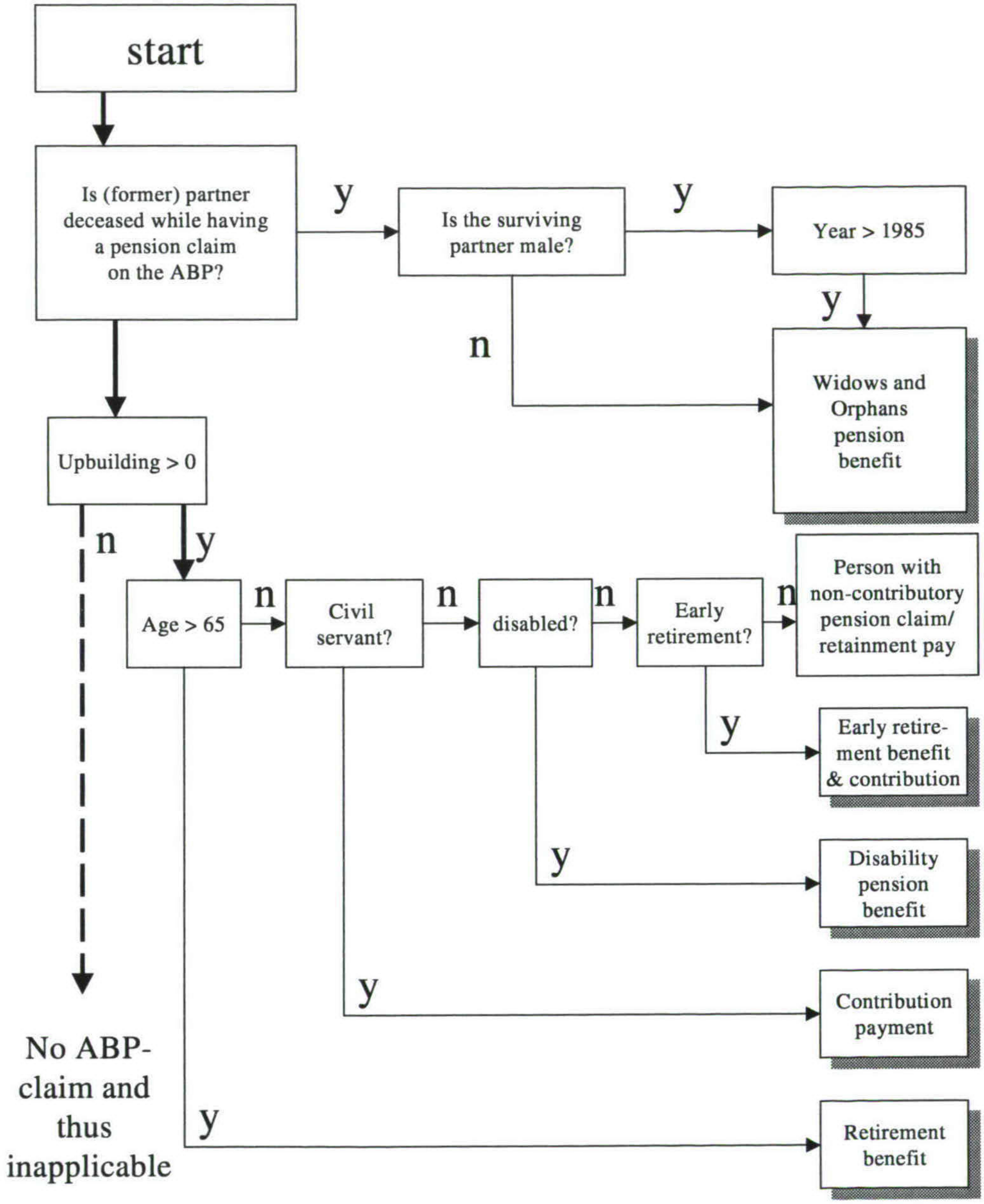

Figure 5.1: flow chart for the ABP in NEDYMAS and classification of individual members in the pension fund.

Being a non-contributing participant basically means that the pension claim which has been built up in the past remains unchanged (apart from a correction for the development of wages) waiting for the moment that the individual becomes eligible for a pension allowance[32].

To recapitulate: all individuals who can be found in the pension fund in a certain year, belong to one of the following groups: if one is older than the retirement age, one receives an old-age pension. If, on the other hand, one is younger than the retirement age, one is either an active participant (if one is currently a civil servant), an early retirement beneficiary, disabled or a non-contributing participant or a retainment pay beneficiary. Lastly, independent of whether or not one is a participant in the pension fund by itself, one can be eligible for a widows/widowers (WW&O) pension benefit

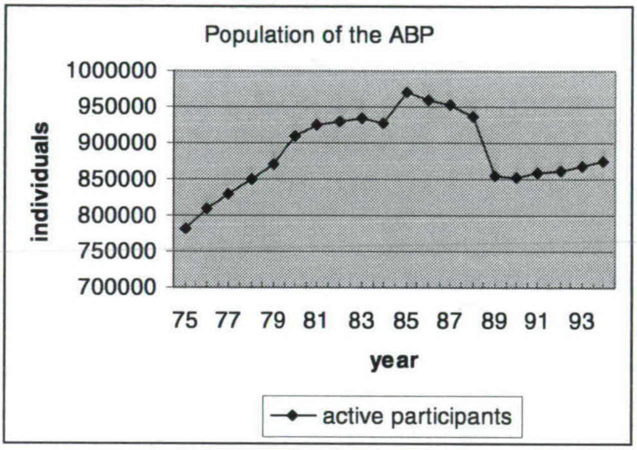

Figure 5.2: population of the ABP: active participants.

As can be seen from the figure 5.2, the number of active participants has been rising quite fast from the beginning of the seventies until about 1984. From that year on, due to increasing state budget cuts and the continuing process of privatisation of state enterprises, the number of active participants decreased. An example of the changes which caused this development was the fact that the National Postal and Telegraph Service (P.T.T.), which was a public organisation whose employees were civil servants, became privatized in 1989. As a consequence, these employees ceased to be active civil servants and no longer participated in the ABP (see a.o. ABP, Annual

[32] It is also possible, of course, that he or she dies, in which case the partner or former partner (if any) becomes eligible to a Widows/Widowers and Orphans pension benefit, based on the upbuilding which our individual did when he or she was a civil servant.

Report 1991, statistical appendix, p. 7) This privatisation involved about 82,000 individuals (ABP, Annual Report, 1990, p. 22). It can be expected that the effect of a change in the number of active participants over the number of pension beneficiaries is by no means immediate but only emerges over the years. So, the discontinuity in the number of active participants should have no -or a very limited short-run effect on the number of pension beneficiaries. Only the number of disability pension beneficiaries could reflect the change in the number of active participants in the shorter run, since the risk of becoming disabled is not limited to certain age groups. In other words, if the actual number of civil servants decreases, given an unchanging disability probability, the number of disabled civil servants will react faster than -say- the number of old-age pension beneficiaries. But in all cases, the effect of such a sudden decrease of the number of active participants over the number of individuals in the other categories will only gradually become visible. This is confirmed by looking at the course of the number of old-age pension beneficiaries, disability pension beneficiaries and WW&O-pension beneficiaries (figure 5.3). These numbers show a steady and continuous increase, with the growth of the number of disability pension beneficiaries slowly lagging behind. This development is also caused by the fact that the medical examinations which were required for a disability pension benefit, became more strict from the beginning of the nineties onwards. But what could be more important is the strong development of the early retirement scheme in the eighties (see figure 5.4). This made it possible to retire early and with a higher pension benefit, without having to apply for a disability pension benefit.

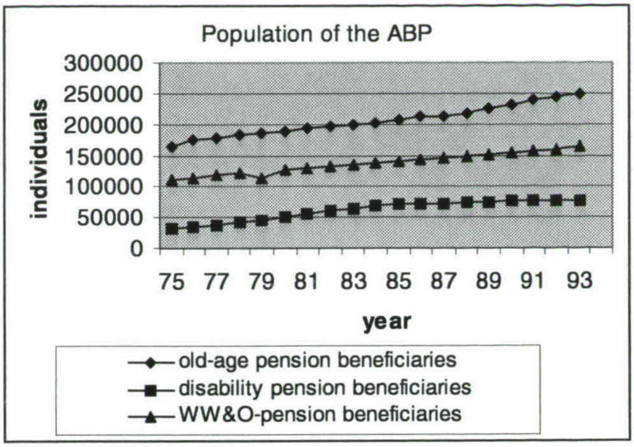

Figure 5.3: Population of the ABP: pension beneficiaries.

The group of old-age pension beneficiaries grows a bit faster than the other two groups, especially compared to the group of disability pension beneficiaries, and it will be shown in the next part that this slight increase is an indication of things to come.

The early retirement scheme came into operation in 1981 and immediately became extremely popular. As can be seen from the figure 5.4, the number of Early Retirement beneficiaries rose very steeply until about 1986. In the annual report of 1986 the ABP mentions that the minimum age at which one can become eligible for an early retirement benefit has decreased (ABP Annual Report, 1986, p. 22). In the following years, the resulting increase of the number of early retirement beneficiaries turned out to be even higher than the ABP expected in 1986. Clearly, the costs of early retirement became increasingly heavy to bear for the ABP. This induced a discussion over whether or not the early retirement scheme should be maintained or eventually be replaced by a flexible pension system[33]. These increasing costs for the ABP where the main motivation not to continue temporary decreases of the minimum eligibility-age. The effect was that the number of early retirement beneficiaries reached a maximum around 1990 and then started to decrease[34].

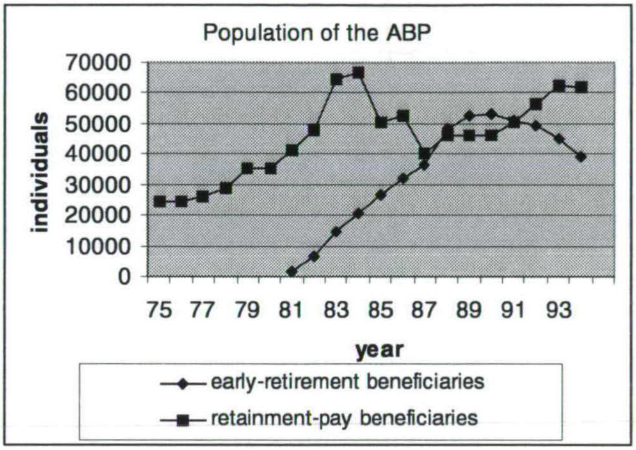

Figure 5.4: Population of the ABP: pension beneficiaries.

As could be expected from the increase of the course of the number of active participants before 1985, the number of retainment pay beneficiaries decreased, simply because the number of layoffs decreased. The line of reasoning is the same as in the case of the number of disabled: given

[33] See, for instance, Annual Report 1990, p. 22, A.R. 1991, p.18, ABP Rapport Grondslagenonderzoek 1989-1993, p.14.

[34] For instance, the so-called DOP-arrangement (Wet bevordering Doorstroming OnderwijsPersoneel) of 10 juni 1988, an arrangement allowing teaching staff to enter the scheme at the age of 55 or 57, was abolished in 1990 (see AR, 1987, p.28 and AR 1990, p.23).

an unchanging layoff-probability, the lower the number of civil servants, the lower the number of civil servants which are laid-off and which therefore become eligible for a Retainment-pay benefit. However, after the number of active participants reached a maximum in 1986 and started decreasing, the number of retainment pay beneficiaries rose. From the beginning of the nineties, this inverse relation between the number of active participants and the number of retainment pay beneficiaries no longer holds. Even though the former increases again, the latter does the same. A possible explanation for this could be that the average length of career of a civil servant decreases, which is equivalent to saying that both the hiring rate and the layoff-rate increases. Note that the discontinuous decrease of the number of active participants (civil servants) as a result of the privatisation of the National Postal and Telegraph Service did not affect the number of retainment pay beneficiaries. The reason for this is simply that these individuals were not laid off, but that they switched from the public to the private sector.

Next, the course of the assets of the ABP is presented in figure 5.5. Given the increasing

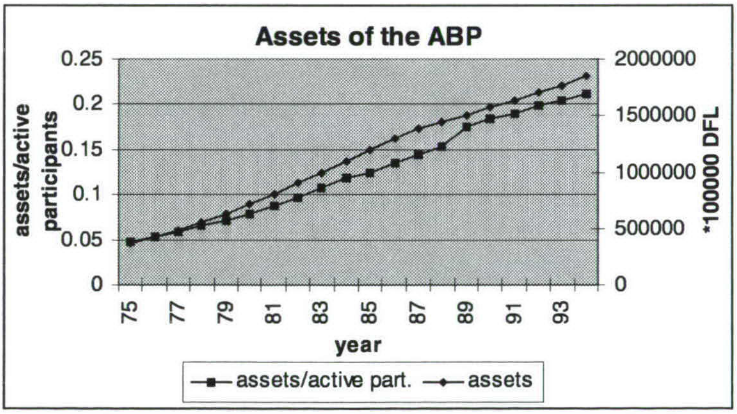

Figure 5.5: Assets of the ABP.

number of active -and therefore contributing- participants, the continuous increase of the assets is not surprising. In fact, In 1994, assets reached no less than 185 billion guilder. However, the same figure also shows the ratio of assets over active participants and this ratio increased as well. So, the development of assets is not so much caused by the development of active participants but by economic conditions, such as the development of wages and the return on investment instead.

In the same time that assets increased, the contribution rate decreased (see figure 1.3). Moreover, the large decrease in the number of active participants in 1989 only had a very small effect on the growth rate of assets (thereby increasing the ratio of assets and active participants). These two seemingly contradictory phenomena suggest that investment gains became an increasingly important determinant of the growth rate of assets. This is confirmed by the last figure, figure 5.6, where it can be seen that the fund experienced high nominal rates of return during the eighties[35].

Of course, the conclusion that the increase of the assets imply that the ABP increased its financial buffer against future pension claims would be wrong, since the increase of the assets is

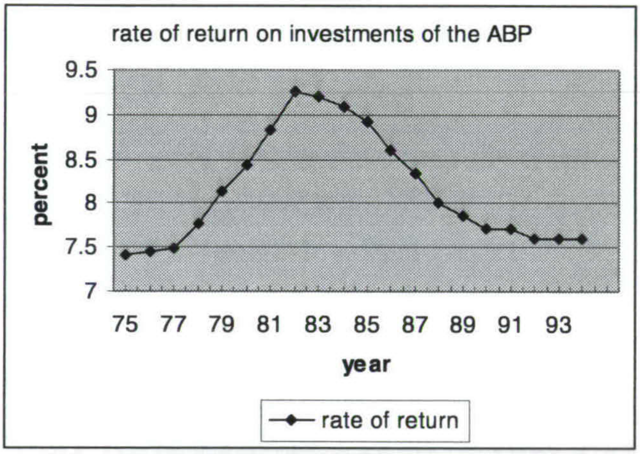

Figure 5.6: Rate of return on investment.

only one side of the coin. One should also take the expected future pension claims into account. This subject will be returned to in the next chapter.

Now we know who is eligible for what benefit, if any. But how is the actual benefit determined? The specific old-age and WW&O-pension allowances of the ABP proceeds from a final-wage system, which means that the benefit is a certain function of the final wage, the number of

[35] Weighted average of the rates of return on various investment categories. Source: various Annual Reports of the ABP.

years which the individual has been contributing to the pension system and the type of the pension[36]. In this context, the *total upbuilding* and *annual rate of upbuilding* must be defined. Each year that an individual participates in the pension fund, his or her future pension claim increases by 1.75% times the annual rate of upbuilding, which depends on the 'status' the individual has in the pension system. The pension which an individual becomes eligible for when reaching the retirement age, is a fraction of the wage-base, where this fraction is 1.75% times the total upbuilding. So, the rate of upbuilding is the speed in which the pension claim as a fraction of the wage-base, increases per year. As said, this speed in which the pension claim increases in one year, i.e. the annual rate of upbuilding depends on the situation the individual is in with respect to the pension fund. This is reflected in figure 5.7 on the next page. For instance, consider the annual increases of the relative pension claim (the annual upbuilding rates), represented by the dotted lines in the graph. Any year that an active individual is a civil servant, his upbuilding increases by one. His annual upbuilding *rate* is thus equal to one. This does not necessarily mean that he or she actually contributes to the scheme: if the wage of the individual is below the exemption, the individual does not contribute, and builds up a pension benefit of zero guilder. Note that, as said in footnote 11 in the first chapter, the exemption is corrected for part-time workers. For the other groups of participants, the upbuilding rate differs from 1. Early retirement beneficiaries and retainment pay beneficiaries have an annual upbuilding rate of .5. The annual upbuilding rate of individuals receiving a disability pension depends on the degree of disability, but is on average .91 for men and .87 for women. It is these averages which are used in the model. Lastly, old-age pension beneficiaries and non-contributing participants of course do not contribute at all and their annual upbuilding is zero. The small and continuous arrows relate the pension allowance which various groups of participants are entitled to, to the wage on which they are based. Generally, the pension of different categories of beneficiaries is either a function of the fictitious old-age pension allowance or of the wage-base itself. The formation of the old-age pension benefit is shown by the large continuous arrows.

[36] In the first part of this study, the definition 'number of participation years' was mostly used. However, this is misleading as it suggests that this number is an integer for every year that an individual contributes to the pension fund. Notwithstanding that it is indeed the case for active full-time participants, it is not true for other groups like early retirement benificiaries. Therefore, it is more precise to refer to 'annual upbuilding rates' instead, where this is indeed the same as the number of participation years if one is an active participant.

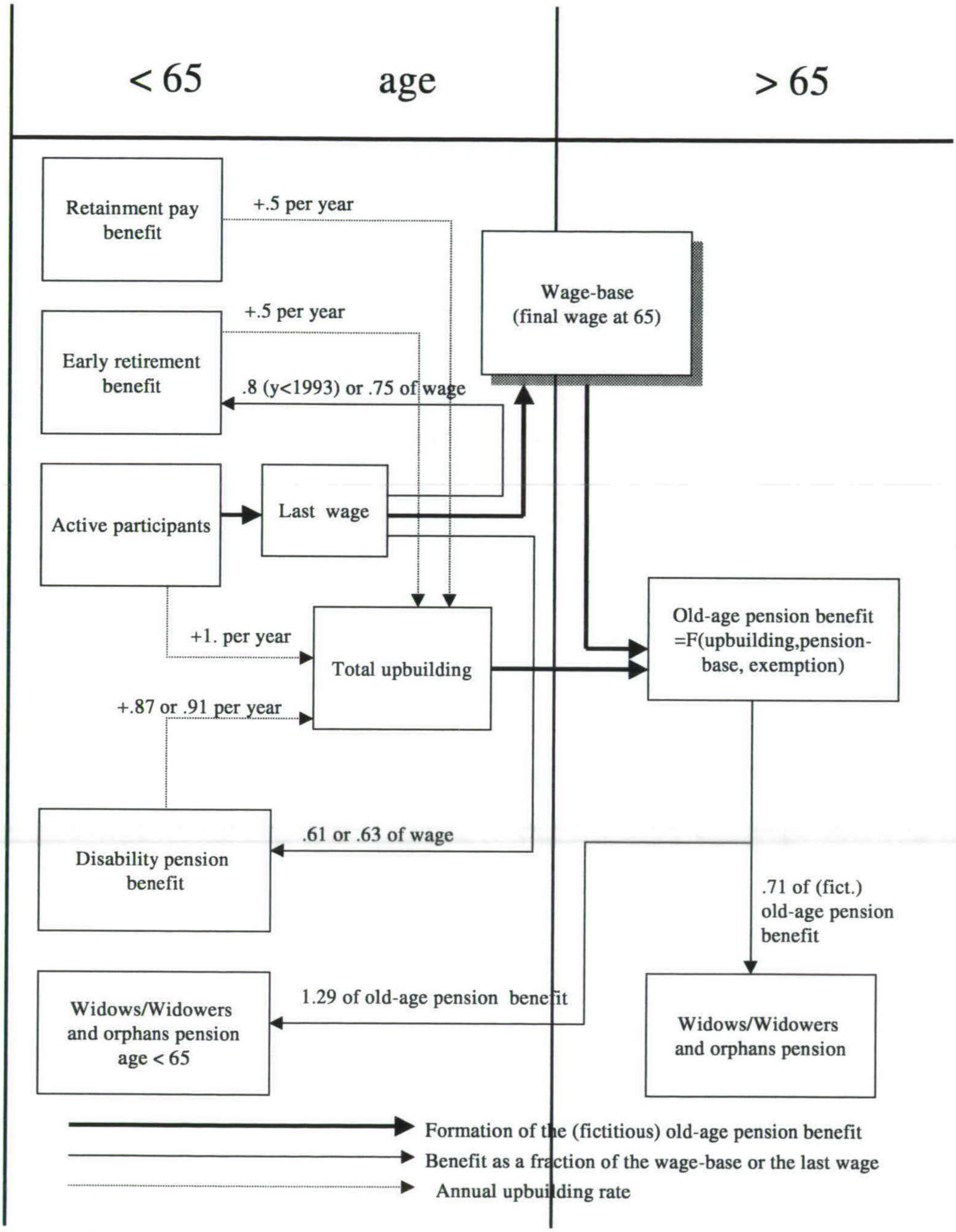

Figure 5.7: Annual upbuilding-rates and pension bases: what determines the pension claim?

The disability pension and the early retirement pension are both derived as a fraction of the wage which the individual earned the year before entering the scheme, where the disability pension benefit takes an exemption into account. The disability pension depends on the degree of disability. However, to keep things workable, the actuarial models of the ABP itself use an average percentage of 61% for men and 63% for women and these figures are used in this model as well. Before 1993, the early retirement pension benefit was 80% of the final wage instead of the pension base. In 1993, this percentage was decreased to 75%. The fixation of the WW&O pension is a bit more complex, as it is equal to five-sevenths of the fictitious old-age pension allowance which the deceased partner would have had *if he had continued working until reaching the age of 65*. So, the total upbuilding of the deceased individual is increased with the difference between the 65 minus the age of the individual and this is multiplied by the pension base (being the final wage minus the exemption). If the beneficiary (i.e. the surviving partner) is younger than 65, this annual allowance is increased by 12.9%. The orphans pension benefit is 1/7 and 2/7 times this fictitious old-age pension benefit, for half- and full orphans. Actuarially speaking, thus taking the average number of children of a new widow or widower into account, the ABP uses an average orphans allowance of 60% of the widows/widowers pension, so the widows/widowers allowance is in turn increased with 60%[37]. The contribution rate, a fraction of the annual wage minus the exemption, is set either by law (before 1995) or -using actuarial information- by the ABP. Active participants pay the full contribution, whereas the contribution rate which early retirement beneficiaries and retaining pay beneficiaries face, is half the contribution of active participants. Individuals receiving a WW&O-pension benefit, a disability pension or an old-age pension, as well as those having a non-contributory pension claim, do not contribute. Next, what are the transition possibilities which the model disentangles and how important are they in reality? Consider table 5.1[38], showing the number of transitions between the various pension-states, between the end of 1992 and the end of 1993, as a fraction of the number of individuals in each state at the end of 1992. In other words, The number of individuals transiting

[37] The upgrade of 12.9% for surviving partners younger than the retirement age does not correspond to the actual percentage either, but is based on actuarial notions as well, The actual pension-upgrade for WW&O benefiaries is 15%, but since beneficiaries who remarry lose their drawing rights on this upgrade, the average upgrade is only 12.9%.

[38] Based on figure 1, Rapport Grondslagenonderzoek ABP, 1993, p. 10.

from a certain state to another are represented as a fraction of the initial number of individuals in the departure state.

Table 5.1: relative numbers of transitions of participants of the ABP, between the end of 1992 and the end of 1993.

From/to	Disability	Early retirement	layoff (incl. Ret. Pay)	Old-age	WW&O
Active	0.30 0.22, 0.80	0.50 0.00, 3.40	3.60 3.60, 4.00	0.10 0.00, 0.50	0.12 0.10, 0.30
Disability				6.40 0.00, 8.90	0.26 0.93, 0.00
Early retirement				13.60 - , 13.60	0.00 - , 0.00
layoff (incl. Ret. pay)				0.19 0.00, 0.97	0.00 0.00, 0.00
Old-age					3.10 - , 3.10

Based on ABP, 1991, figure 1, p. 10. Own calculations, based upon data provided by the ABP. In each cell, three figures are found, describing the situation of individuals in the fund between the end of 1992 and 1993. In the first line, the relative number of transitions for the whole population is given The first and second number of the second row are the relative numbers of transitions of individuals younger or older than 50. The proportion of individuals who do not transit are 95.4% (active participants), 86.4% (early retirement), 97.6 (non-contributing participants), 92.5 (disabled), 94.7 (retirees) and 94.2 (WW&O-beneficiaries).

Note that there is no column 'active', nor is there a row 'WW&O' included in table 5.1. The reason is that there is no transition possibility from any state to the active state within the pension scheme itself. This does not mean that one could not re-enter the active state when one was a non-contributing participant. This is of course possible, but such a transition would in fact go via the labour market and not via the pension fund, such as -for instance- the transition from being an active participant to the old-age pension state. The same goes for the transition possibility from a WW&O pension beneficiary to any of the other states. Again, this is possible, but it is independent from the pension system we are now describing[39]. The transition possibilities which the model disentangles are represented by grey cells in table 5.1. If one is an active participant, one can either become disabled, an early retirement beneficiary, a non-contributing participant (in the case of layoff), an old-age pension beneficiary or a WW&O-pension beneficiary. However, if one is in one of the inactive states, the number of possible exit states shrinks to two. One can reach the retirement age and become eligible to an old-age pension benefit or one could become eligible to a WW&O-pension benefit.

The numbers in this table are based on a representative data set of 10,000 participants in the pension fund ABP and the figures in the cells are therefore a snapshot of the situation at the end of 1992 and 1993. The rows contain the 'departure states' whereas the columns are the arrival states. In each cell, three figures are found. In the first line, the relative number of transitions for the whole population is given. In the second row, the first number is the relative number of transitions of individuals younger than 50. The second number is obviously the relative number of transitions of individuals older than 50.

If there are no observations in the departure state, the relative number of transitions is replaced by a score. This is sometimes the case for individuals younger than 50 as, for instance, there are no individuals younger than 50 in the 'old age pension' cell. Of course, this being the case, the general relative number of transitions for the whole population (first row in the cell) is bound to be equal to the relative number of transitions of individuals older than 50 (the second figure in the second row of the cell). For instance, of the individuals receiving a disability pension at the end of 1992, 6.4% is found to have retired before the end of 1993. However, of course, there are no disabled individuals younger than 50 who retire, so the relative number of transitions of individuals older than 50 who retire is by definition equal (if the number of disabled individuals younger than 50 is zero) to, or larger than, this 6.4% (if the number of disabled individuals younger than 50 is

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[39] Note that it is still possible for an individual to be active and a WW&O pension beneficary *at the same time*. As said before , whether or not one is a WW&O beneficiary depends on the characteristics of the late partner which has nothing to do with whether or not the WW&O beneficiary is a civil servant.

positive), since the same number of transitions (of individuals older than 50) is divided by a lower number (not all the disabled individuals, but only the disabled individuals older than 50). Indeed, it is higher, namely 8.9%.

It is conspicuous that the transition percentages are quite low. As only relative transitions are represented, the percentage of individuals remaining in the same state between the end of 1992 and 1993 are not represented, but will be given for completeness' sake. These numbers are not specified for individuals younger and older than 50 and are 95.4% (active participants), 86.4% (early retirement), 97.6 (non-contributing participants), 92.5 (disabled), 94.7 (retirees) and 94.2 (WW&O-beneficiaries). The vast majority of the participants in the various categories clearly do not change between the end of 1992 and the end of 1993. Another interesting thing is that the relative number of transitions from the active state to the old-age pension is very low (0.5% for the active participants older than 50). The relative number of transitions is somewhat higher between the active state and the early retirement benefit (3.4% for the participants older than 50). This, combined with the fact that the relative number of transitions between early retirement and retirement is more than 13% for all participants and the participants older than 65, suggests that most active participants reach the retirement state via the early retirement state. The same goes for the disability state, though to a lesser extent.

The relative numbers of transitions from the active states to the other states are higher for individuals older than 50, compared to their younger fellow-civil servants. The exception to this is the relative number of transitions towards the 'retainment pay- and layoff state'. This is hardly surprising and is confirmed by the fact that mortality rates, disability rates and early retirement rates increase with age, which will be shown later.

So, for all the transition possibilities depicted in table 5.1., the specific transition probability is available, specified to age and gender. Moreover, the proportion of those who are married in the year of death is given for various categories of participants. These probabilities are used in the derivation of the contribution rate, since the ABP uses this information in their premium-setting process as well.

The relation between the transition probabilities (as presented in the figures below) and the transition possibilities (table 5.1) is given in appendix 1 and the most important transition probabilities are given in figures 5.8 to 5.12 to be discussed now.

These age-specific transition probabilities are based on five-year-averages up to 1988 and the ABP uses them as a basis for its expectations upon. They will serve the same function in the actuarial model to be presented in the next paragraphs. Note that these probabilities are not used to determine actual transitions in the microsimulation model NEDYMAS. Actual transitions in the model are determined by the demographic module and the module describing the transitions between the various labour market states. Thus, the transition probabilities which the pension fund uses in its actuarial process of setting the contribution rate, need not be the same as the 'true' demographic transition probabilities which NEDYMAS uses, just as the transition which a pension fund uses to form its expectations need not be equal to the observed transition probabilities.

Next, the most important of these age-specific transition probabilities will be presented and discussed. First of all, in figure 5.8. the mortality rate is given for active participants of both sexes. As could be expected, these mortality rates increase with age. Men generally face a higher mortality rate than women, and this difference becomes clearer for higher ages. In the next figure 5.9., the mortality rates of male and female retired participants are given. Given age, the mortality rate of men is again higher than the mortality rate for women, but the difference is very small, as compared with the situation for active participants. It appears that a selection of men takes place before they reach 65.

In figure 5.10., disability rates of male and female active participants are given. The course of both time series is as expected until the age of about 58. The older one is, the higher the disability rate. However, between 58 and 61, disability rates decrease significantly. One could think of two possible explanations for this. The first of these would be that, as age increases, the number of active participants decreases. Basically, there is a selection process, as was the case in the mortality rates: only the strong remain and the probability that a certain active participant becomes disabled, therefore decreases. Moreover, and this is the second possible reason, it is possible that a number of individuals choose to enter the early retirement scheme, who otherwise would have become disabled, since the early retirement allowance is generally higher than the Disability pension allowance. Another striking thing is that women face a higher disability rate than men.

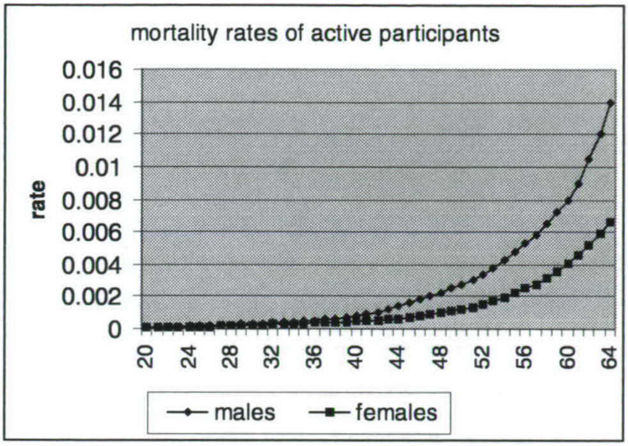

Figure 5.8: mortality rates for active participants. Source: ABP, 1991, part II, p.2 and 4.

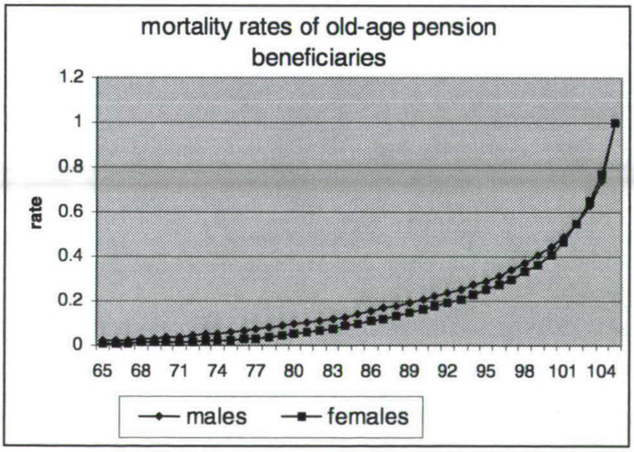

Figure 5.9: mortality rates of old-age pension beneficiaries. Source: ABP, 1991, part II, p.34 and 36.

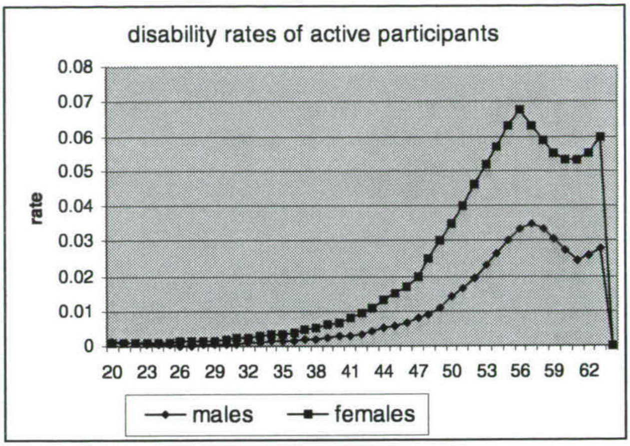

Figure 5.10: disability rate of active participants. Source: ABP, 1991, part II, p.6 and 8.

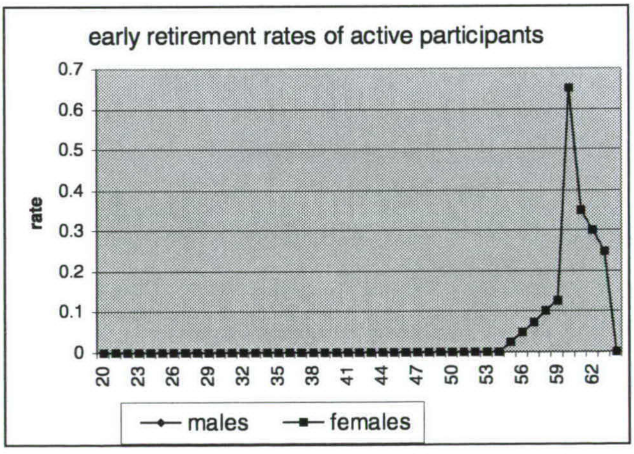

Figure 5.11: early retirement rates of active participants. Source: ABP, 1991, part II, p.22 and 24.

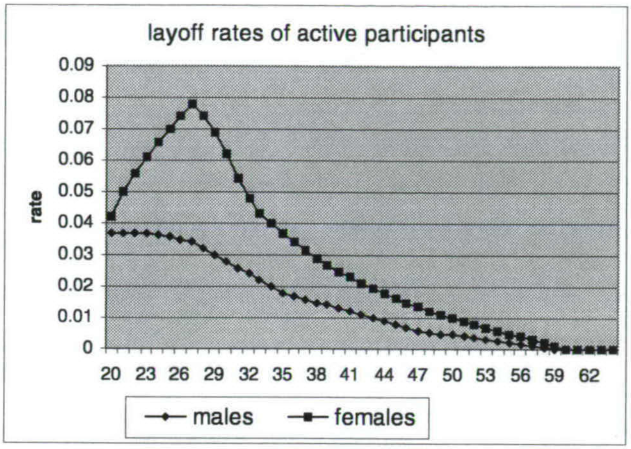

Figure 5.12: Layoff rates of active participants. Source: ABP, 1991, part II, p. 10 and 12.

The course of the early retirement probability over age, as is shown in figure 5.11, is less striking. For young male and female individuals, the probability of entering an early retirement scheme is practically equal to zero and this remains as such until the age of about 55. From then on, the probability that one enters an early retirement scheme increases enormously, and reaches a peak around the age of 60. After that, the probability decreases rapidly, the main reason being probably that those who decide to enter the early retirement scheme, generally do so as soon as possible. An interesting point is that these rates are the same for both sexes.

The selection of which individual transits from being a civil servant to the early retirement state introduces a problem. In its original version, NEDYMAS does disentangle early retirement beneficiaries, namely those individuals who are younger than 65 but who are retired anyway, but does not keep track of what state these early retirement beneficiaries came from (i.e. the private or the public sector). Moreover, this selection process is based on rather rough data for both civil servants and private sector employees. Of the group of early retirement beneficiaries which NEDYMAS forms, a part is in some way linked to the ABP (former civil servants) and a part is not, but we do not know who. Early retired civil servants are therefore by mistake included in the out of the labour market state, and should in some way be disentangled from early retirees which came from the private sector. This is done as follows: first, using the early retirement probability, it is decided whether or not a civil servant becomes eligible for an early retirement benefit. If this is the case for a specific civil servant, an individual of the same age and gender is selected from the out of the labour market state, and this individual transits from the out of the labour market state to the early retirement benefit state. Thus, the early retirement beneficiaries are selected from the risk set of civil servants but disentangled from the out of the labour market state. When looking at figure 5.12., which shows the layoff rates of male and female participants, some things are interesting: first of all, the layoff probability decreases over age for both sexes and, secondly, men face a lower layoff probability than women. In an earlier study, a four-state transition model was developed and applied to the labour market data of

the Dutch Socio-Economic Panel (Dekkers, 1994). This study not only suggested that the human capital value of men (still) was higher than that of women, but also argued that those individuals with the highest human capital value would have a higher probability to transit from the private sector to the government. Hence the higher layoff rate for women (with a lower human capital value) than for men. This line of reasoning explains the continuously higher layoff rate for women as compared to men and implies that layoff is involuntary. Secondly, a remarkable discontinuity which should be explained is the strikingly high layoff rate of women in their twenties and early thirties. It is likely that most women have their first child in their late twenties and, relative to other countries, women still very often decide to step out of the labour market and become housewives. So, at least in this respect, the layoff is 'voluntarily' in this case, in the sense that the woman is not forced to resign by her superiors, but merely by circumstances.

After having discussed the general outline of the pension fund and some of the relevant transition probabilities, let us now turn to the specific discussion of how the (internal or actual, depending on the year) contribution rate is set. The general framework of how the (future) pension costs and premium base are constructed is presented in the appendix to this chapter. In what follows, the point of departure will be the more general case of a full-time worker. In the case of part-time work, the exemption and the annual upbuilding are adjusted *pro rata temporis* as described in footnote 11 and the discussion of figure 5.7.

5.2. The civil servants' pension fund ABP before 1995.

As said in paragraph 3.2, the actual contribution rate which the ABP levies, was exogenously set in the ABP-law of 1966, in combination with a number of structural and temporarily measures. So, the contribution rate was not directly dependent on actuarial notions. Moreover, this contribution rate was designed only to cover old-age pensions, Disability pensions and WW&O pensions, so that the cost of the early retirement scheme had to be fully borne by surplus funds and -interest receipts. However, merely for internal use, a so-called 'base-rate premium' was defined. In this paragraph, the way in which the base-rate premium is modelled will be presented, since it allows for showing the general actuarial formulations in a much easier and clear-cut situation than in the next paragraph where the actual contribution rate is modelled, based on the same formal system. The base-rate premium is defined so as to equalize the present expected value of the different pension allowances (denoted **N**) and the present expected value of the income on which contribution payments are based (denoted **B**). This base-rate premium is derived for the group of individuals who are first-year participants and can be written as[40]:

$$P_{br_t} = \frac{N_t}{B_t} \tag{5.1}$$

In order to know the course of this fictitious base-rate premium, we need to derive the aggregated expected present value of the old-age pension, the disability pension and the WW&O pension for the group of those entering the pension system. Even though the formal descriptions and derivations are left to be discussed in the appendix 2, both the numerator and the denominator will be explained while keeping the actuarial formulations only in a somewhat more general form

[40] This formulation is based on Kuné, 1995. p.3. However, according to mr. Paulis, senior actuarial expert at the APB, the base-rate as used by the ABP is essentially a moving average of the above formulation, thereby incorporating the information of various subsequent yeargroups of incoming participants. However, this difference does not basically change the base-rate, it just makes its course smoother over time. This, together with the fact that it is just a 'representation variable' with no actual consequences, was the reason to stick to the above 'one-year'- version.

5.2.1. the present expected value of the income: the numerator of the contribution rate.

The numerator N_t is derived as follows: an individual enters the pension system at a certain age. For 35 years (or for all the years from today to the year in which the individual reaches the age of 65), the discounted value of the expected old-age pension, disability pension and WW&O pension for which the individual could become eligible, are derived. These individual and annual figures must then be totalled for all years between the age of entrance and 65 and then aggregated over all individuals which enter the pension system in that year.

So, for each year *t* and for each individual *in* (who is age_{in} years old in the year *t*) in the group of entering participants, the discounted values of the annually-gathered *discounted expected value of the future pension claims* are aggregated over this year and all future years (in which the individual will be of age $i \geq age$) for a maximum of 35 years, or $i - age \leq 35$, or until retirement (i=65). This aggregation of every individual over all current and future years is then aggregated over *b* individuals in the various states. This then results in N_t:

$$N_t = \Sigma_{in=1}^{b} \Sigma_{i=age_{in}}^{MIN(age+35,65)} \left(\frac{A + B + IP_{i,in}^{DIS}}{(1+r)^{i-age}} \right)_t$$

$$A = (OP_{i,in}^{A} + OP_{i,in}^{ERB,RP}) \tag{5.2}$$

$$B = (NP_{i,in}^{A} + NP_{i,in}^{ERB,RP} + NP_{i,in}^{DIS} + NP_{i,in}^{NCP})$$

OP, *NP* and *IP* stand for old-age pension, WW&O pension and disability Pension. The superscripts *A*, *ERB* and *RP* stand for being Active, an Early Retirement beneficiary and a Retainment Pay beneficiary. Likewise, the superscripts *DIS* and *NCP* denote Disabled and a Non-Contributing Participant. Lastly, and not included in the above equation, *RET* denotes Retiree (an old-age pension beneficiary). Every period between today and 35 years (or the year that the individual retires), the individual faces the 'risk' of remaining an active participant. In other words, any period between today and the year in which the individual reaches the retirement age, he or she faces a certain probability that he or she remains in the active state. The extra discounted expected value of the pension claim which an active participant becomes eligible for in that year, multiplied by the probability that the individual indeed remains active from *age* (i.e. today) to *i*, is denoted OP^{A}_{i}. This is one of the key variables in the model.

However, an individual of course also faces a certain probability of either becoming an Early Retirement beneficiary or a Retainment Pay beneficiary. In this case, the upbuilding of a future pension continues, but at a different speed (figure 5.7). This extra discounted expected value of the pension, which the Early Retiree or Retainment Pay beneficiary will gather in the year *i*, times the probability that the individual does not remain active but enters an Early Retirement scheme or a Retainment Pay scheme instead, is denoted $OP^{ERB,RP}_{i}$.

Thirdly, there is a possibility that the individual becomes disabled. In this case, he or she becomes eligible for a Disability Pension, while the upbuilding of a future old-age pension cost continues. This (compound) current and future expected value of the Disability pension claim and old-age pension claim which is built up in the year *i*, times the probability that the individual becomes disabled at *i*, is denoted IP^{DIS}_{i}.

Lastly, the individual faces a certain probability of death. In this case, if he or she is married, the spouse becomes eligible for a certain WW&O pension, of which the discounted future expected value pension times the probability that the individual deceases at *i*, is denoted NP_i.

Note that the formulation of the various OP and NP are all *given that the individual is an active participant today*. Thus, in order to have the notation correct, it should be written as $OP^{A|A}$, $OP^{ERB,RP|A}$, $IP^{DIS|A}$ and so forth. However, adding this '|*A*' to the notation does not add anything to the model itself since *every* participant is active today. In order to keep things simple, this superscript has been omitted. Notwithstanding this, the reader should remember that, for instance, OP^{A} should be seen as $OP^{A|A}$, since this difference will become relevant in the next paragraph.

Another way of defining the above is the following. For an individual who is 20 years of age, OP^{A}_{30} is the discounted expected value of the old-age pension for which he or she becomes eligible in ten years, given the probability that he or she reaches the age of 30 while being an active participant. Likewise, $OP^{ERB,RP}_{30}$ is the discounted expected value of the old-age pension benefit for which the individual can expect to become eligible, given the probability that he or she enters an Early Retirement scheme between 20 and 30 (quite unlikely, as can be seen from figure 5.10) or becomes eligible for a retainment pay[41].

In short, every year, the individual builds up a certain expected value of an old-age pension (which is corrected for the probability that the individual deceases before reaching the retirement age), a disability pension and a WW&O pension. The above formulation of *N* is therefore basically an expected value calculation: the probability that the individual remains active or enters one of the other states is multiplied with the total upbuilding of the discounted (future) old-age pension, disability pension and WW&O pension.

In appendix 2, the actuarial formulations will be derived for only one individual, So the subscript *in* becomes irrelevant and will therefore be omitted. Moreover, the subscript *t* is irrelevant as well, since the current age of the individual (*age*, which changes with *t*) is one of the main variables in the model.

To summarize, the base-rate premium is the ratio of the aggregated discounted expected value of the total pension and the aggregated discounted expected contribution base or the wage. For each year *t* in which individual *in* is *age* years old, the expected discounted annual future pension claims are aggregated over all future years $i > age$ until retirement. This, in turn, is aggregated over *b* individuals, in the various states, which results in N_t, formulated in equation 5.1.

5.2.2. The present expected value of the contribution-base: the denominator of the contribution rate.

The second step in determining the base-rate premium is determining the denominator of equation 5.1. The variable B_t reflects the aggregated discounted expected value of that part of the income which is the premium base. In other words, for each individual the future discounted

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41 The pension benefit *he expects to become eligible for at 30* is not the same as the pension benefit *he can expect to receive at 65, given his situation at 30*. The latter would for instance involve including 1*(65-30) or .5*(65-30) (for an active participant, respectively an early retirement- or retainment pay benefiticary in order to take future contribution years into account. This is not the case for OP^{A}_{i} or $OP^{ERB,RP}_{i}$, but since the annual upbuilding of the future pension claim is done for all years between the current *age* and the retirement age, it boils down to the same thing, since the pension benefit which the individual of 20 years can expect to receive at 65 is reflected by the 'flow' of the annual values of OPA, OPV and so forth, from now until the retirement age.

expected income minus the exemption is aggregated over all future years up to the year in which he or she reaches the age of 65. These individual pension bases are then aggregated over all first-year participants, resulting in B_t. Thus, disregarding the aggregations which were introduced when presenting equation 5.1, we look for the discounted expected future value of the contribution base for a first-year participant who is currently *age* years old. Given a certain unknown constant contribution rate P_t, the sum of the discounted expected contributions can be written as:

$$(B_t) = \Sigma_{in=1}^{b} \Sigma_{i=age_{in}}^{65} [\ Q_{A,exit}(i-1,i) \times \frac{Q_{A,D}(age,i_{in})}{(1+r)^{65-i_{in}}} \times E(wage(i_{in})) \times P_t\ + \\ Q_{ERB,exit}(i-1,i) \times \frac{Q_{ERB,D}(age,i_{in})}{(1+r)^{65-i_{in}}/} \times E(income^{ERB}(i_{in})) \times 0.5 \times P_t] \quad \textbf{(5.3)}$$

Remember that there are *b* first-year participants who are age_{in} years old. Thus, for all first-year participants, the expected value of the contributions which they will pay until either reaching the retirement age or until ceasing to be an active participant and under the assumption of a certain contribution rate P_t. Assume that P_t is age-independent (or independent from *i*), which is the case since the ABP uses a continuation-premium system, then it can be secluded from the double summation in the last equation. In other words, the aggregated discounted value of expected contributions can then be written as B_t times P_t, where B_t denotes the pension-fund-wide-aggregated discounted expected contribution-base. This latter variable can be found by substituting P_t out of equation 5.3.

As said, in any period, the contribution rate must be set such that the discounted expected pension allowances are equal to the discounted expected contribution base. The pension fund-wide contribution rate P_t can then be written as $P_t=N_t/B_t$ (5.1) Where N_t and B_t are defined in equations 5.2. and 5.3.

5.3. The civil servants' pension fund ABP from 1995 onward.

As a direct result of the privatisation process the ABP went through, and is still going through today, the exogenous contribution rate was abolished and replaced by a contribution rate which incorporates actuarial notions concerning current and future pension claims - and contributions. So the actual contribution rate becomes endogenous. The second main difference with the pre-1995 situation is that the contribution only covers old-age pension and WW&O pension. Early retirement benefit, as well as the disability pension scheme are organised outside the ABP[42] and are financed by a PAYG-scheme (Kuné, 1995, p.14). The current and future old-age pension and WW&O pension thus determines the contribution through a so-called 'synthesis-premium'. This synthesis premium is a weighted sum of a (long term) continuation premium P_{lt} and a (short term) annuity K to restore the rate of coverage to its target value of 110%. The synthesis contribution rate can be written as $P_{s,t+1} = P_{lt,t+1} + (1-w)*K_{t+1}$, where w is the weighting factor, reflecting the importance of long-term notions in the contribution rate. However, as this model is typically long term and as short-term discontinuities do not occur, it was decided to abandon the modelling of K. The long term contribution rate is basically a continuation premium and can be written as:

$$P_{lt,t+1} = \frac{\textit{Present Value current and future pension claims} - \textit{assets}}{\textit{Present Value current and future contribution base}}$$

$$P_{lt,t+1} = \frac{(N_t^A + N_t^{RET} + N_t^{NCP} + N_t^{WW\&O} + N_t^{ERB,RP} + N_t^{DIS}) - V_t}{B_t} \tag{5.4}$$

N_t^A : present value of total expected future old-age and WW&O pension claims of current active participants at time t.

N_t^{RET}: present value of total expected future old-age and WW&O pension claims of current retirees at time t.

N_t^{NCP} : present value of total expected future old-age and WW&O pension claims of current non-contributing participants at time t.

$N_t^{WW\&O}$: present value of total expected future WW&O pension claims of current WW&O pension beneficiaries at time t.

$N_t^{ERB,RP}$: present value of total expected future old-age and WW&O pension claims of current early retirement beneficiaries and retainment pay beneficiaries.

N_t^{DIS} : present value of total expected future old-age and WW&O pension claims of current

[42] These schemes are organized by the foundation Early Retirement Funds (Stichting VUT-fonds) and the Fund for Disability Insurance Civil Servants (Fonds ArbeidsOngeschiktheidsverzekeringen OverheidsPersoneel, FAOP), respectively (ABP, Annual Report, 1994, p.8)

disability pension beneficiaries.

B_t : present value of total expected future contributions of current active participants.

V_t : total assets.

Note that $N_t^{WW\&O}$ includes only the discounted expected value of future WW&O benefits of ongoing claims i.e. of those who are beneficiaries today. Old-age pensions are not included in $N_t^{WW\&O}$ since it is quite possible that a beneficiary (whose late partner was a claimant) is not a claimant him- or herself.

So, contrary to the base-rate contribution as presented in the last chapter, the synthesis contribution rate is based on information of all active participants, as well as disabled, (early-) retired and WW&O pension beneficiaries. Moreover, only future old-age and WW&O pension costs are taken into account. As was the case in the pre-1995 ABP model, the present expected value of the total future pension claims of individuals in every state is the sum of the present value of the expected future old-age pension claim (OP) and the present value of the expected future WW&O pension claim (NP) of the participants in that specific state. Thus, OP and NP must be specified, not only for those individuals being active participants (A) at the current age, *age*, but also for those being disabled (DIS), early retirement beneficiaries (ERB), retirees (RET), retainment pay beneficiaries (RP) and non-contributing participants (NCP). Moreover, contrary to the situation before 1995 where only the information on the group of newly entering (active) participants was of relevance, the information of all 'cohorts' of participants in the various categories must be taken into account. Thus:

$$N^{A} = \sum_{in=1}^{no(A)} \sum_{i=age_{in}}^{MIN(age+35,65)} \left(\frac{(OP_{i,in}^{A|A} + OP_{i,in}^{ERB,RP|A} + OP_{i,in}^{DIS|A}) + (NP_{i,in}^{A|A} + NP_{i,in}^{ERB,RP|A} + NP_{i,in}^{DIS|A} + NP_{i,in}^{NCI}}{(1+r)^{i-age}} \right.$$

$$N^{RET} = \sum_{\epsilon=1}^{no(RET)} \sum_{i=age_{\epsilon}\geq 65}^{100} \left(\frac{OP_{i,\epsilon}^{RET|RET} + NP_{i,\epsilon}^{RET|RET}}{(1+r)^{i-age}} \right)$$

$$N^{NCP} = \sum_{\epsilon=1}^{no(NCP)} \sum_{i=age_{\epsilon}}^{MIN(age+35,65)} \left(\frac{OP_{i,\epsilon}^{NCP|NCP} + NP_{i,\epsilon}^{NCP|NPC}}{(1+r)^{i-age}} \right) \tag{5.5}$$

$$N^{ERB,RP} = \sum_{\epsilon=1}^{no(ERB,RP)} \sum_{i=age_{\epsilon}}^{MIN(age+35,65)} \left(\frac{OP_{i,\epsilon}^{ERB,RP|ERB,RP} + NP_{i,\epsilon}^{ERB,RP|ERB,RP}}{(1+r)^{i-age}} \right)$$

$$N^{DIS} = \sum_{\epsilon=1}^{no(DIS)} \sum_{i=age_{\epsilon}}^{MIN(age+35,65)} \left(\frac{OP_{i,\epsilon}^{DIS|DIS} + NP_{i,\epsilon}^{DIS|DIS}}{(1+r)^{i-age}} \right)$$

$$N^{WW\&O} = \sum_{\epsilon=1}^{no(WW\&O)} \sum_{i=age_{\epsilon}}^{MIN(age+35,100)} \left(\frac{NP_{i,\epsilon}^{WW\&O|WW\&O}}{(1+r)^{i-age}} \right)$$

where N^A, N^{RET} and so forth are defined in appendix 2..

As announced in the last paragraph, the notation becomes a bit more complex since the assumption that every participant is active in the current year no longer holds. Thus, $OP^{DIS|A}$ (being a part of N^A) denotes the annually gathered discounted value of the expected future pension of an individual *who is currently an active participant*, multiplied by the probability that he or she becomes disabled and thus enters a Disability pension scheme. Likewise $NP^{NCP|NCP}$ (being a part of N^{NCP}) denotes the annually gathered discounted value of the expected future WW&O pension of an individual who is currently a non-contributing participant and multiplied by the probability that the individual remains a non-contributing participant. Of course, the correspondence between, say, $OP^{DIS|A}$ and $OP^{DIS|DIS}$ is that they are both based on the discounted expected future pension of a disabled individual. The difference is that the first requires the multiplication of this discounted value with the probability that a currently active participant does not decease and becomes disabled in a future period, whereas the second requires the multiplication of this discounted value with the probability that a currently disabled individual remains disabled (i.e. does not decease). Moreover, as explained in depth in appendix 2, the number of 'exit states' for those individuals who are not active participants, is limited to one: death. This results in a considerable simplification of the actuarial equations.

The equation describing N^A - the present value of total expected future old-age- and WW&O pension claims of current active participants- consists on the one hand of the summation over all future years of the annually gathered present value of the old-age pension if the current active individual either remains active ($OP^{A|A}$), enters an early retirement scheme or a retainment pay scheme ($OP^{ERB,RP|A}$) or becomes disabled ($OP^{DIS|A}$). On the other hand, for every future year, the annually gathered present value of the WW&O pension if the current active individual either remains active ($NP^{A|A}$), enters an early retirement scheme or a retainment pay scheme ($NP^{ERB,RP|A}$), becomes disabled ($NP^{DIS|A}$) or a non-contributing participant ($NP^{NCP|A}$)[43].

This ends the brief description of the ABP-model both before and after 1995, the year in which the ABP became privatized. However, some things are still covered. Before turning to the

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[43] The reason why the annually gathered present value of the expected old-age pension benefit of the active participant given that he or she becomes a non-contributing participant ($OP^{NCP|A}$) is not included, simply because it is equal to zero, since the rate of upbuilding of non contributing participants is zero. However, this is not the case for the expected WW&O pension benefit. If the individual becomes a non-contributing participant, the pension claim only increases with the wage index.

most interesting part of this study, namely the presentation and discussion of the simulation results, these things must be uncovered briefly as well, in order to be complete. How are the assets of the ABP exactly modelled? What about the starting value of the rate of upbuilding? These, and other aspects, are dealt with in the next paragraph. The reader who is less interested in the 'technical' side of empirical modelling, might find it tempting to skip the next paragraph and jump directly to the next chapter. Indeed, reading this next paragraph does not increase insight into the model as presented in these two last paragraphs.

5.4. Some examples of ad-hoc modelling.

Before closing this chapter in order to turn to the actual simulation results of the model, some 'loose ends' must be dealt with. In this last paragraph, a couple of subjects which are of less interest with respect to the research problem are presented. The first concerns the way in which the number of civil servants is determined. Next, the way in which the pension funds' assets are modelled and, thirdly, what rate of return is used, and how this is modelled and simulated will be discussed. These ad-hoc models have been kept as simple as possible.

a) the number of civil servants.

The future macroeconomic number of civil servants is determined by a simple autoregressive model of the following form.

$$LD_g = 95.842 + 0.013855{*}LD\_1 + 0.78531{*}LD_g\_1 \qquad \textbf{(5.6)}$$

$$\quad (1.04) \quad (0.80) \qquad\qquad (13.45)$$

$R^2 = .93 \qquad DH^{44} = 1.91$

LD_1 = total effective labour demand (or employment), lagged by one period.

LDg = labour demand government.

Ldg_1=idem, lagged by one period.

So, in this model, the labour demand of the government is determined by its own lagged value and the total effective labour demand, which is an exogenous time series. Put differently, the

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[44] Durbin H-statistic.

number of civil servants in a certain period is an important determinant for the number of civil servants in following periods and in steady state, the labour demand is linearly related to the effective labour demand. It should be mentioned that the choice for the above equation, and its form, is only for practical reasons: its quite high explanatory value and its stable development over time. So, the above equation determined the effective labour demand of the government, i.e. the number of civil servants in a certain year. The labour market module of NEDYMAS then 'decides' who becomes a civil servant and who ceases to be one.

b) Assets

The first question which will be answered, is how assets are modelled. This is done by a vintage-type of model, which can best be explained using figure 5.13. It is assumed that the average length of the investment period (or the average number of years in which investments made in a certain year, generate the same real rate of return) is 15 years. In a certain year, the total sum of assets thus consists of 15 vintages of which the newest vintage is 'filled' by the balance of (incoming) contributions and (outgoing) pension payments. This figure is augmented with the oldest vintage of investments which (after 16 years) becomes available for reinvestment against the most recent rate of return.

The model assumes an average turnover of investment of 15 years. Indeed, the assumed average length of the investment period is in practice longer than 15 years. In fact, various annual reports of the ABP show that the average number of investment years decreased from 18.3 in 1986 to 15.5 in 1991.

However, there are reasons to believe that this average number of years will decrease further and become lower than 15 years in the future. Before 1995, the ABP faced quite stringent investment regulations, of which probably the most important was that each year, the ABP had to loan half of its annual contribution receipts to the government (Kleynen, 1996, chapter 3, p. 45-46). The result was that most assets were invested in unregistered loans, of which a vast majority were loans to the government. This is shown in table 5.2 where the various investment categories are shown, both in million guilder and as a percentage of total investments. Table 5.2 shows that this pattern was already going on before 1989. In 1986, unregistered loans amounted to almost 100 billion guilder or 76% of investments. In 1989, unregistered loans as a percentage of total investments had decreased to 69.9%. From then on, the decrease became stronger, resulting in a 43% share of unregistered loans in total investments in 1996.

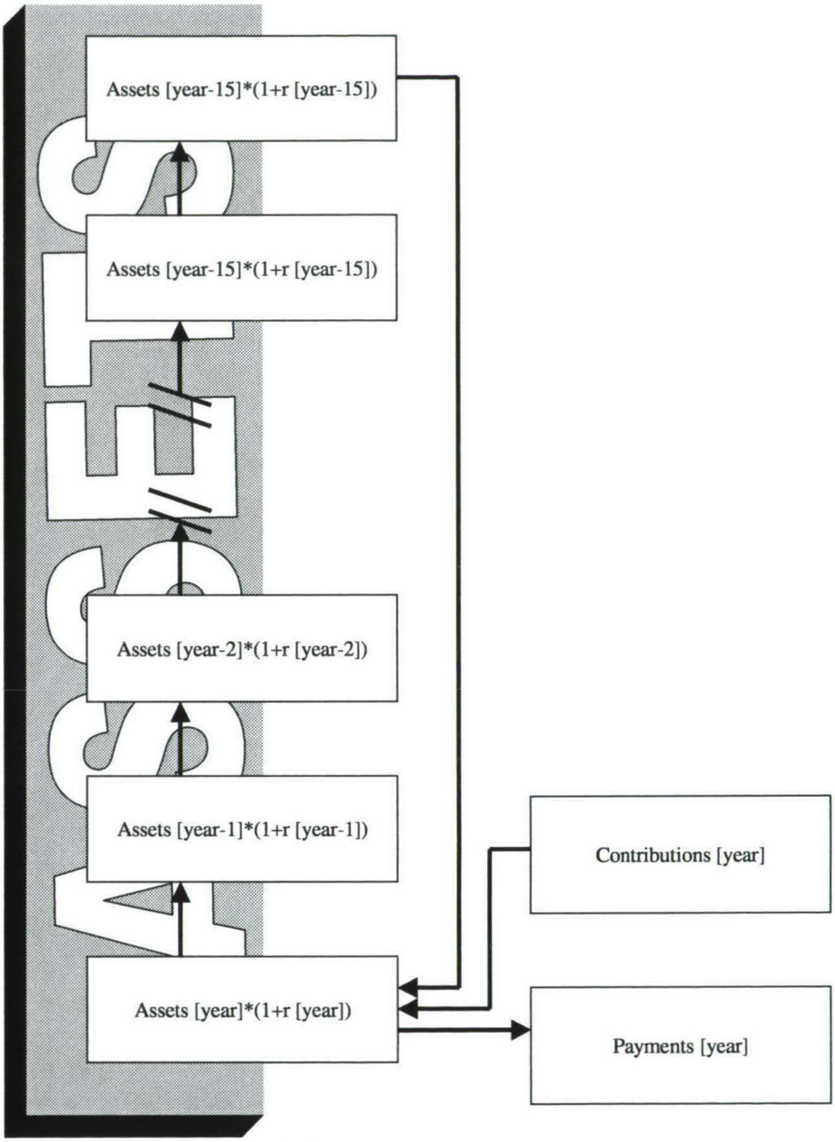

Figure 5.13: assets of the ABP.

More volatile investment categories gained importance during the same period. The proportional size of bonds increased from almost 12% to about 25%. But the increase of stocks is the most remarkable: in 1986, stocks accounted for about 1,6% of total investments (2,1 billon guilder). This increased to about 5% in 1989. In 1995, the (privatized) ABP became subject to the Pension and Savings Act -like all other pension funds. One of the results was that the investmentregulations were no longer imposed. Stocks immediately became an important investment category, nowadays accounting for 20% of total investments.

Table 5.2: investments of the ABP.

	1986	1987	1988	1989	1990	1993	1994	1995	1996
unregistered loans	99199	102367	102824	104233	106946	103960	102290	100565	92107
mortgages	5343	6312	7547	9217	10097	16066	17580	18483	19124
bonds	15559	18417	21071	21224	21097	29161	34698	38996	51971
stocks	2122	2711	3687	5527	7889	13723	16266	32206	44086
real estate	7927	8268	8326	9110	10112	12256	12240	16777	19165
%-of total investments									
unregistered loans	76.22	74.06	71.30	69.32	67.88	58.67	55.22	51.42	43.71
mortgages	4.11	4.57	5.23	6.13	6.41	9.07	9.49	9.45	9.08
bonds	11.95	13.32	14.61	14.12	13.39	16.46	18.73	19.94	24.66
stocks	1.63	1.96	2.56	3.68	5.01	7.74	8.78	16.47	20.92
real estate	6.09	5.98	5.77	6.06	6.42	6.92	6.61	8.58	9.1

Source: Various Annual Reports of the ABP.

Given the patterns in table 5.2, the rate of turnover of investment is likely to have continued the decrease shown in figure 5.14 and there is no reason to believe why this would not be the case in the future. Thus, allowing for, say, 20 vintages of assets can be expected to be too much, given

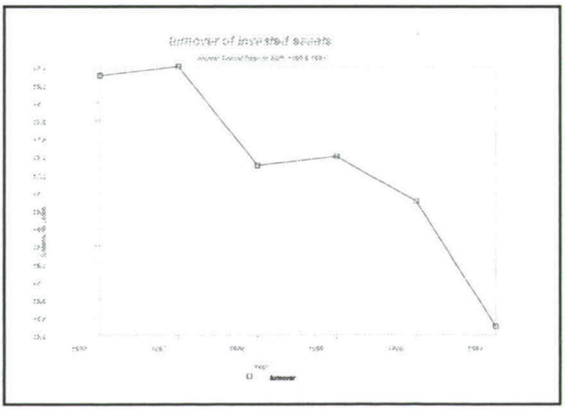

Figure 5.14: average turnover in years of invested assets.

that the simulations will be done for the distant future. This was the main motivation in pinpointing the average turnover to 15 years. Of course, setting the number of vintages below the actual number of vintages in a certain year, makes the course of the assets react more strongly and rapidly to a changing real rate of return. Thus, choosing the number of vintages in the assets-model is a quite important decision, notwithstanding the fact that the result remains quite arbitrary.

c) the real rate of return on investments.

One of the more important variables in the context of a pension fund, is the real rate of return on investments. As said in the first chapter, some authors consider this the main determinant for a certain pension outcome, given the inlay. The motivation for taking the variable as exogenous has already been given , but it can be considered a decision important enough to explain again. In the context of our model, there is again an antithesis between short-term simulation results and long-term considerations. For instance, adopting some sort of Asset-Liability model of investments for the fund[45] would not only be beyond the scope of this study, but its simulation results are typically short-term. As the simulation period of this model is 114 years (from 1947 to 2060), this is hardly applicable.

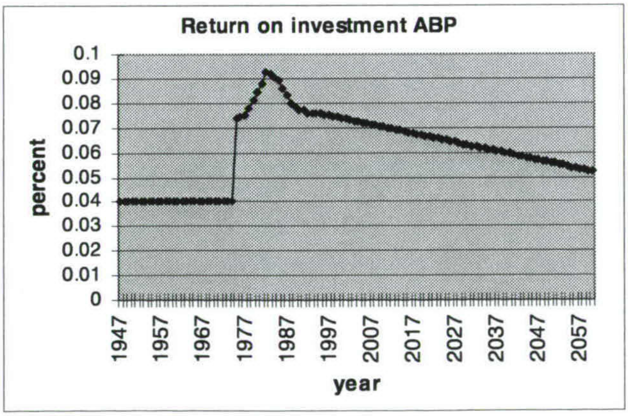

Figure 5.15: return on investment of the ABP.

[45] See, for instance, Kleynen, 1996, van Aalst, 1993, van Aalst, 1995 and and Möhlmann-Bronkhorst, 1988.

As opposed to this, adopting a (semi-)exogenous long-term rate of return[46] would overcome this problem, but would result in bad (short-term) fit of the simulation results with the actual course of the rate of return. It has been tried to link NEDYMAS to a macroeconomic module (Dekkers, et.al., 1993, Baekgaard et.al., 1997), but this attempt unfortunately failed. Secondly, the rate of return can be considered a quite important variable, a poor simulation fit could jeopardize the credibility of virtually all variables and could ultimately make the answering of the problems as presented in the first part of this study unreliable. Thirdly, over the period in which data is available, the rate of return is quite discontinuous, as figure 5.15 shows. So, there is a crucial variable, the simulation of which by a separate model is beyond the scope of this study, even if there were a type of model which would be optimal in these circumstances. And fourthly, given the open character of the Dutch economy and the ongoing integration of European capital and stock markets, it is not likely that any simulation results will cause changes in the real rate of return of the fund.

For these reasons, it was decided to start from a different and much more practical angle: the rate of return on investment was taken as an exogenous variable, whose development is chosen on practical grounds. From 1947 to 1974, for the first year of which there is exogenous information, the rate of return is assumed to be equal to the actuarial discount rate of 4%, a development which is chosen precisely in order to make the assets fit as well as possible. Between 1974 and 1994, the problem of an awkward and discontinuous course of the actual rate of return on investment of the ABP was overcome by simply adopting it as an exogenous variable and using the values as shown in figure 5.6 in paragraph 5.1. After that, for reasons mentioned earlier, no model was used, but the variable was kept exogenous as was the case before 1994. Starting from the rate of return in 1994, it was assumed that the real rate of return would decrease slowly to the long-term discount rate of the ABP, which is 4%. Of course, this is a rather crude assumption, and it is therefore interesting to see what the consequences of this decision are. So, one of the simulation variants of which the results will be presented and discussed will have a real rate of return which will decrease to this 4% as well, but then much faster. This will be returned to when discussing the simulation variants.

[46] for instance Huijser & van Loo, 1986, van Heerwaarden et.al., 1996.

5.5. Summary.

In this chapter, the actuarial equations underlying the (actual or, before 1995, fictitious) contribution rate, have been brought forward. Even though the formulae themselves are somewhat inaccessible, the basic system is very simple: taking into account the various transitions individuals can make with respect to the pension fund, the expected value of the various pension allowances for which they could become eligible, are discounted and added up. This results in a figure reflecting the pension fund-wide average value of the expected future pension claim of the current participants whose information is used. This expected future pension claim is then confronted with the discounted and expected value of that part of the income of the participants which forms the basis of the contributions made to the pension fund. The resulting ratio clearly is the contribution rate.

The way in which this contribution rate is set by the ABP has gone through considerable changes: before 1995 -the year in which the ABP became a private organisation, the actual contribution rate was exogenous and not or only very indirectly related to actuarial notions. Moreover, it included old-age pensions, disability pensions and WW&O pensions. The costs of early retirement were not taken into account (or maybe in the annual political process of setting the actual exogenous contribution rate), although the ABP had to cover these costs as well. Actuarial information was incorporated in the base-rate contribution which was for internal use only (although it is quite possible that its practical value stems from the fact that it could be used in the negotiation process of setting the actual contribution rate). This base-rate contribution was set in such a way that for the group of first-year participants, the aggregated future old-age pension, disability pension and WW&O pension are equalised to the aggregated future pension base. The first part of this seventh chapter has been devoted to modelling this base-rate contribution.

From 1995 onward, the situation changed profoundly with the privatisation of the ABP. The most conspicuous change was that the contribution rate is no longer exogenously determined, but is a weighted sum of a continuation premium and an annuity. Unlike the base-rate contribution, both the continuation premium and the annuity are based on information on all the active participants (and therefore not only the first-year participants), as well as the participants receiving an old-age pension and a WW&O pension and the future benefits of the so-called non-contributory participants. The information concerning early retirement benefit and Disability pension is included and reflected by a separate contribution rate, even though the management of both schemes is transferred to other organisations.

Here ends the second part of this study. In the first part, the problem definition was presented and discussed in greater depth. Here, the problem of whether or not intergenerational redistribution of income via capital funding pension schemes, does exist, was approached from theory and placed in the context of the Dutch system of additional compulsory pensions, notably the civil servants pension fund ABP. A conclusion drawn in this first part was that the only way in which intergenerational and intragenerational income flows could be disentangled was by modelling a pension fund in a microsimulation model.

In the second part of this study, the various modules describing the pension fund ABP were presented and discussed. Much attention was given to the actuarial model underlying the (fictitious) base-rate premium (before 1995, the year in which the ABP was privatized) and the actual continuation premium (from 1995 onward).

In the following and third part of this study, the simulation results will be presented and discussed in order to answer the questions posed in the first part. First of all, the simulation results of the model will be presented and compared with historical information. This way, the model can be validated. Then, the effect of the pension fund as described in the third part, on the lifetime income of subsequent cohorts of participants will be presented. The model clearly keeps exogenous circumstances constant as much as possible. This way, the simulation results can be used as a benchmark, a base-variant to compare the simulation results of variants with. These variants will be formed by partially changing a certain variable in the model. One of the most straightforward examples of such a variant is changing the wage-base of the (actual or expected) pension from the final wage to the average wage. This way, the research question as to what (if anything) exactly causes and/or affects intergenerational income redistribution, can be answered.

Part III:
Simulation Results.

Chapter 6: simulation results

Introduction

In this chapter, the simulation results will be presented and discussed. The microsimulation model generates vast amounts of information concerning the (modified) sample and the course and distribution of lifetime data. This means that we will have to restrict ourselves as much as possible to what we really need to show, which is lifetime income and the redistribution of it.

This chapter will start by describing one of the most important ways in which the model was calibrated, namely by confronting the development of the various categories of individuals in the model with their historical courses[47]. These developments were discussed extensively in chapter 7. Here, we consider the fit of the simulation results with these historical figures. Next, the lifetime incomes and inequalities of lifetime-incomes for the various simulation variants will be presented, and the development of aggregated simulation results, such as assets and the discounted value of pension claims, will be discussed.

6.1. annual simulation results

6.1.1. Categories of participants in the pension fund.

First of all, we compare the historical and simulated number of active participants in the pension fund. These are the civil servants who contribute to the pension fund, and who form an actuarial claim on the fund. It can be seen from figure 6.1 that the fit of the simulated number of active participants is rather good. There is only an overestimation during the eighties. Note that the sudden decrease was the result of the privatization of the Dutch Postal and Telegraph Services (P.T.T.) in 1989. As can be seen in figure 6.1, the number of civil servants will continue to

[47] Of course, validation was done on other variables as well. For instance, average age of various categories of participants, average 'upbuilding-factor' were confronted with information from the annual reports of the ABP. Moreover, transition probabilities between various pension-states were compared with the 1992 and 1993-data set which was provided by the ABP. However, these validation results are not included in this text, for it would involve large tables of data and throughout explanations whereas it would not add anything to the conclusions, nor would it make this study anymore interesting.

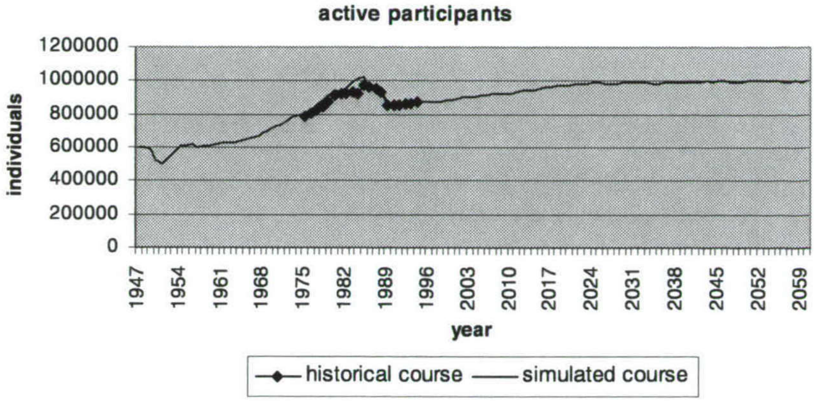

Figure 6.1

increase in the future, but at a lesser speed than in the seventies and eighties. The assumption causing this is that the ratio of civil servants and private sector employees remains constant in the long run. Next, let us consider figure 6.2: the old-age pension beneficiaries.

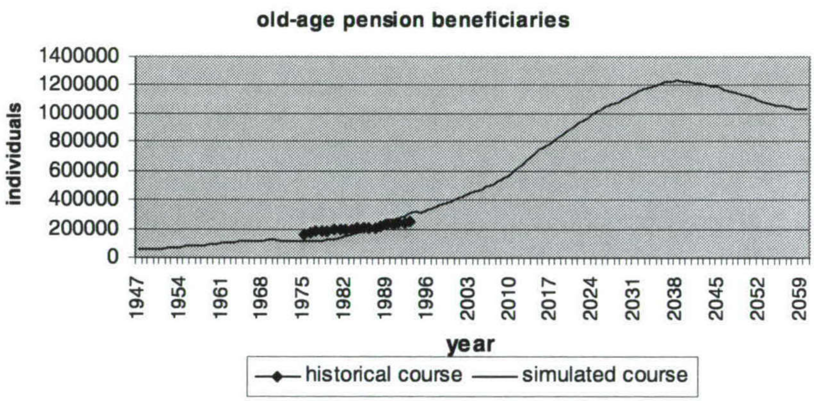

Figure 6.2

Here, the fit is less good, in the sense that the growth rate of the number of old-age pension beneficiaries is somewhat underestimated, at least in the first part of the simulation period. Without giving proof, it can be argued that this is caused by a modest underestimation of the speed at which individuals enter and exit the 'state' of being a civil servant. Put differently, the 'speed of turnover' is somewhat underestimated. Apart from that, the future course of the number old-age pension beneficiaries looks as expected. As ageing gains momentum, the growth rate of the number of pensioners increases up to about 2035. Then it stabilizes for a relatively short period of time, after which a decrease sets in. This development is of course to a large extent determined by the demographic module, which uses forecast-information of the 'Global-Competition scenario' as presented in section 4 of the second chapter. Next, let us consider the disability pension beneficiaries, as shown in figure 6.3.

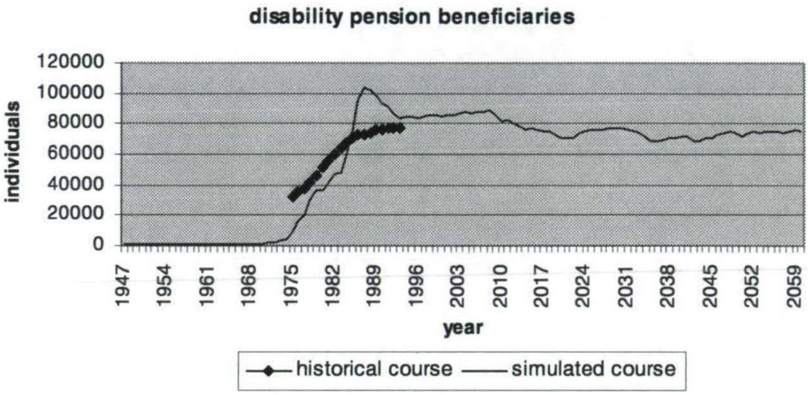

Figure 6.3

Here, getting the simulation results right turned out to be a much more difficult problem, for several reasons. The first and most important reason is that simulations are based upon transition probabilities of only one year, being 1985. This was before the government took a number of measures to reduce the number of disabled, for instance by making the physical examination more restrictive. Secondly, the data which formed the basis of these transition probabilities is not specifically for civil servants. Thirdly, any simulation error in the sample is multiplied by thousand when considering the population[48], so any calibration has large effects on the simulation fit. If the proportional number of individuals in the population is low, as is the case for the number of disabled, such a simulation error has a strong negative effect on the fit. For these three reasons, the development of the number of disability pension beneficiaries is not as good as other variables. The stable future development of the number of disability pension beneficiaries is in contrast with the development during the period between the second half of the seventies until the second half of the eighties. In this period of sharp increase, there seem to

[48] Remember that every individual in the representative data set used for simulation represents almost 1,000 individuals in the population.

have been some sort of implicit and unspoken agreement between employers and employees organizations -as was the case with the General Disability Act WAO- to transfer individuals, who otherwise would have become unemployed, to the disability-pension regulations. It appears that the government, in its role of employer, did the same thing. However, from the second half of the eighties onwards, it was realized that things were getting out of hand. Measures, specifically concerning the more severe medical tests required for becoming eligible for a disability pension, became more severe. Moreover, the strong development of the early retirement scheme or ERB made it less necessary to transfer people to the disability scheme. As there is very little possibility that the medical requirements for being declared disabled will become less strict, the future course of the number of disability pension beneficiaries does not seem very odd, especially given the very stable number of civil servants.

Figure 6.4 shows the simulated number of widow's and widower's pension beneficiaries.

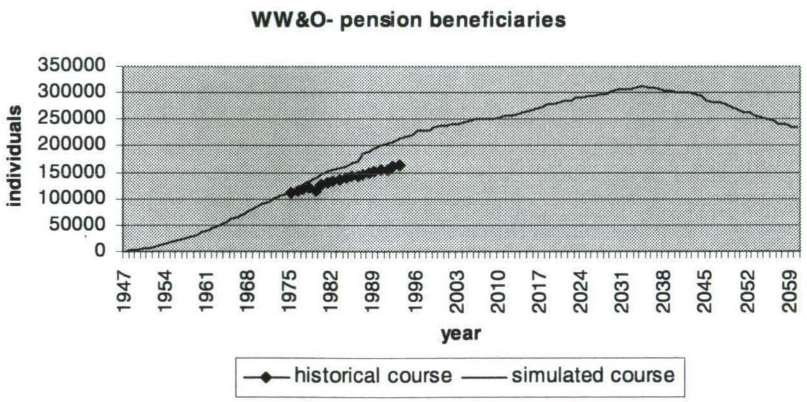

Figure 6.4

Unfortunately, the fit of this variable could be better: in the second half of the seventies, the fit is acceptable, but as the growth rate of the simulated value is higher than that of the historical value, the fit worsens gradually. A possible explanation for this was already explained in footnote 31: from 1986 onwards, men became eligible for an WW&O-pension benefit. However, this measure was only taken in 1989 and was adjusted backwards. So, in 1989, those men whose partners died from 1986 onwards while having made an ABP-claim got their benefit as if they had applied in 1986. However, one could imagine that a number of men did not apply in 1989, even though they met these requirements. This could be because they did not know, or because they expected the benefit to be too low, and so forth. The result would then be that the simulated number of male WW&O-pension beneficiaries would be overestimated for a considerable period of time. However, this still does not explain why the overestimation in figure 6.4 increases over time.

Figure 6.5 represents the early-retirement beneficiaries. The simulation of this category of ex-civil servants caused some problems.

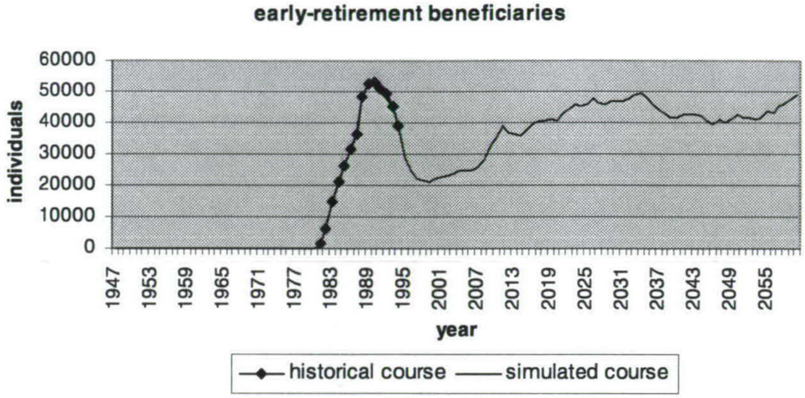

Figure 6.5

In its original setting, NEDYMAS did not simulate the total number of early retirement beneficiaries. Moreover, the very low number of individuals combined with the highly discontinuous development of the number of early retirement beneficiaries made proper dynamic simulation a virtually impossible task. As a consequence, there is no need to discuss the fit, because the historical number of early retirement beneficiaries was exactly selected from the sample of (simulated) civil servants, using the relative transition probabilities as given in figure 5.11. Of course, this was not possible for the period from 1994 onward, since we ran out of historical data. A solution was found by taking a 'snapshot' of the sample of early retirement beneficiaries in the years 1993 and 1994, more specifically the number of early retirement beneficiaries of a certain age as the fraction of the number of civil servants and early retirement beneficiaries of the same age. This snapshot was based upon the same data as underlying table 5.1. In any future year, and again using the relative transition probabilities as entry rates, randomly selected civil servants were shifted to the early retirement-state in such a way that the 'snapshot-situation' was restored. So, indirectly, the future development of the sample of civil servants is used as the basis for the future development of the sample of early retirement beneficiaries. At first, the decrease of the number of early retirement beneficiaries, which started in the beginning of the nineties, persists up to about 2005. From then on, a slow increase sets in. However, the number of early retirement beneficiaries never again reaches the level of the nineties.

The last category of participants in the pension fund which should be considered, actually do not participate in the fund anymore. But they still have a 'frozen' pension claim, since they were civil servants in the past. Unfortunately, not many data-entries of these non-contributing participants could be found, but figure 6.6 shows an underestimation of the number of non-contributing participants, which could be explained by the fact that the high rate of turnover of civil servants in the years after the war is not simulated by NEDYMAS.

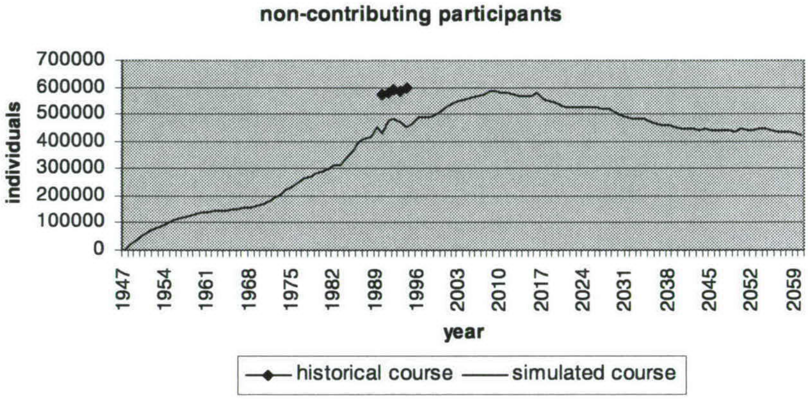

Figure 6.6

6.1.2. Assets, actuarial pension claims and contribution rates.

Next, we consider the assets of the pension fund, which are presented in figure 6.7. This is an important variable, since its development is simultaneously determined by the actuarial discounted value of the future pension claims (which in turn is a function of the final wage) and the discounted future premium base (which is a function of the current wage of the civil servants). The fit of the simulated assets to its historical value is good, though the growth rate of the simulated value is a bit higher than the historical course, at least in the first half of the period of which historical values were known. According to the model, assets will continue to grow at more or less the same speed as they did since the beginning of the eighties, at least until

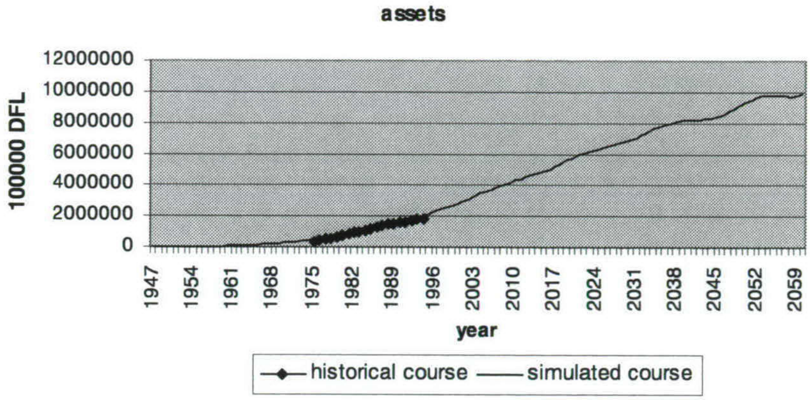

Figure 6.7

about 2025. About then, the total value of the discounted future pension claims will decrease relative to the total discounted value of the contribution-base, resulting in a slowdown of the growth rate of assets. This is shown in figure 6.8 where the total discounted future pension claim, the total discounted future contribution base and assets are shown.

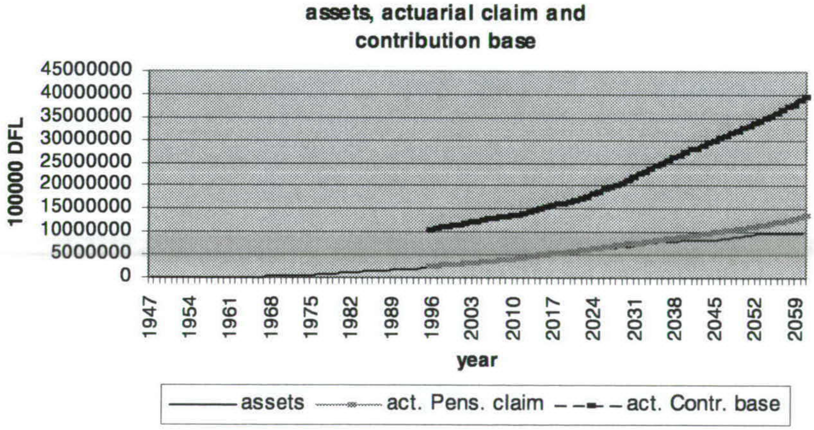

Figure 6.8

The most striking conclusion which can be drawn from figure 6.8 is that the rate of coverage (i.e. the relative distance between the actuarial pension claim and assets) which remains very good up to about 2015, will then gradually decrease. In other words, from that year on, assets will gradually lag behind the actuarial future pension claim. The reason for this is that the total value of future discounted contribution bases will increase at a higher speed than before, thereby causing the contribution rates not to increase as much as needed to maintain the rate of coverage. The explanation for this lies in the fact that the wage-function, describing the relation between the age of the individual and the wage which he or she earns, is among other things such as the individual age, a function of the macroeconomic wage-sum. This reflects the macroeconomic effect of ageing on individual wages, not only for civil servants, but for employees as well. Figure 6.9 shows the development of this wage-sum.

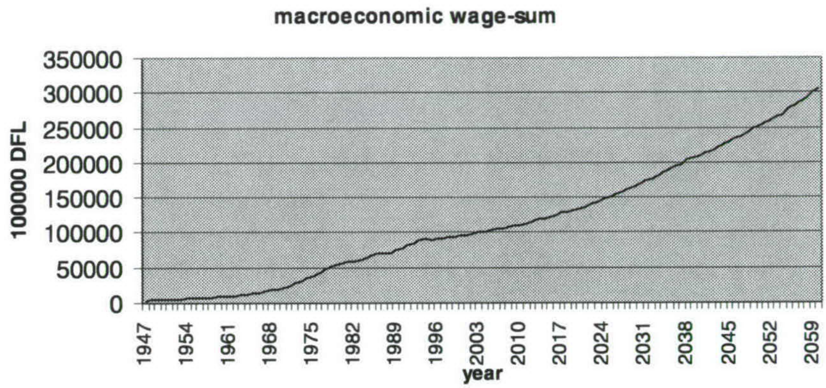

Figure 6.9

For reasons explained in paragraph 2.3.3, the growth rate of the wage-sum will increase from about 2020 onwards. The similarity with the development of the discounted contribution-base is immediately seen. One could however conclude from figure 6.9 that this effect only affects the actuarial contribution base, whereas the growth rate of the actuarial future pension claim seems to remain more or less the same. However, this would not be a correct conclusion: the speed of increase of the actuarial pension claim may be lower than that of the actuarial contribution base, but this is caused by a level-difference in the starting value around 2020. The growth rate of the actuarial pension claim is about the same as the growth rate of the actuarial contribution-base, and even a bit higher.

Next, let us consider the contribution rates, which result from the actuarial model and (in the case of the contribution rate after 1995) the annual level of assets. These are shown in figure 6.10. First, let us recapitulate the various contribution rates which the model disentangles. In the left plane of figure 6.10, i.e. the period before 1995, the actual contribution rate and the base-rate premium are shown. The right plane shows from top to bottom, the total contribution rate and the two contribution rates which it is based upon. These are the contribution rate for the early retirement (ERB) and disability (dis) scheme and, lastly, the well-known continuation premium for the old-age and WW&O-pension scheme.

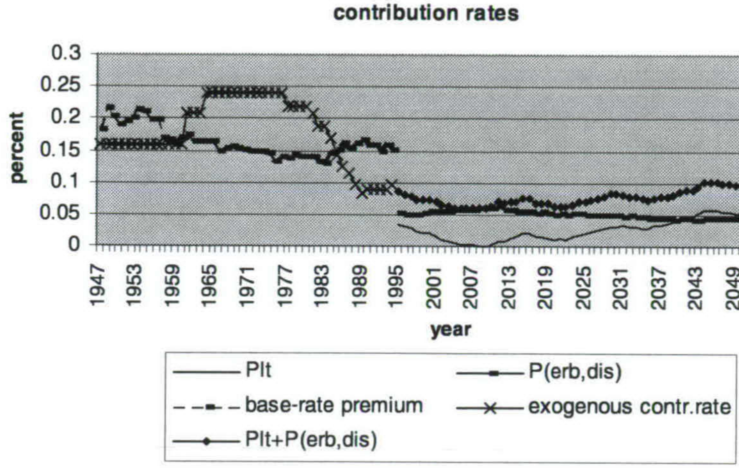

Figure 6.10

These specific contribution rates will now be discussed, starting with the period between 1947 and 1995. Before 1995, the contribution rate was set by the Ministry of Social Affairs. However, merely for internal use of the fund's actuarial experts, but possibly also as an argument in the negotiations between the pension fund and the minister, the 'base-rate' premium was developed. This premium equalized discounted future expected pension claims with discounted future expected contributions for first-year civil servants. This base-rate premium shows a rather continuous decrease over the whole period. The comparison of the base-rate premium with the historical contribution rate immediately shows that contributions made from the beginning of the sixties up to the first half of the eighties were rather high, at least from an actuarial point of view and even taking into account the fact that the base-rate premium is a somewhat optimistic reflection of the future pension costs, since it is (only) based on the information of the newly entered civil servants who on average can be expected to be the most years away from retirement. Moreover, it shows that the rapid decrease of the actual contribution rate was stronger than would have been the case in the case of an adjustment to the base-rate premium. Thereby supporting the suspicion which was expressed in the last chapter, namely that it was motivated not by the desire to adjust to the actuarial situation, but to decrease or stabilize wage-costs for the government, this given the budgetary requirements of the Maastricht Treaty (Dekkers, 1999 (b)).

As said in the last chapter, the situation changed for the ABP in 1995. Disability pension benefits and early retirement benefits (VUT) now became financed through a PAYG-scheme, whereas the contribution rate for future old-age and WW&O-pension benefits became 'dynamically endogenized', meaning that it resulted from the confrontation between assets, future discounted pension claims and the actuarial value of the future contribution base. The simulation results show that this old-age and WW&O- contribution rate (referred to as Plt in figure 6.10) starts at about 3.3% in 1995, then decreases to almost 0% in 2008. This is the result of the high returns on investment in the eighties. From 2010 on, the contribution rate starts to increase, resulting in a value of 9.3% in 2060. The PAYG-premium needed to cover current disability- and early retirement pension benefits (P(ERB+dis) in figure 6.10) starts at around 5.2% in 1995. It remains relatively stable, ending up at 5.0% in 2060. Even though the sum of the contribution rates seems all right, in the sense that it is very close to the exogenous 1994 contribution rate, as figure 6.10 shows, there is reason to believe that the actuarial old-age and WW&O-contribution rate is underestimated, whereas the disability- and ERB-contribution rate is somewhat overestimated. In the case of the old-age and WW&O-contribution rate, a possible explanation for the low contribution rate in the first five years is the vintage-like way in which assets are modeled. As a result of this structure, assets react with a certain delay in relation to changes (in this case decreases) of the rate of return, a delay which might not be as in the real (financial) world. As a consequence, the contribution rate decreases more sharply than it should.

Next, we turn to figure 6.11. Another feature of the model is that it defines an artificial contribution rate, a contribution rate which equalized annual contributions to the annual benefits. Put differently, it is the contribution rate, on condition that the additional pension benefits had been financed though PAYG. To facilitate comparison, this PAYG-premium is expressed together with the total contribution rate (i.e. the sum of the actuarial contribution rate on old-age and disability pension benefits, on the one hand, and the PAYG-premium for disability- and WW&O-benefits on the other hand. Moreover, the historical contribution rate is included as well. Note that measures to calibrate -among other things- the number of old-age beneficiaries, and which were mostly carried out in the starting year 1947, greatly influence the course of the fictitious PAYG-premium. For instance, the high PAYG-contribution rate in the starting year

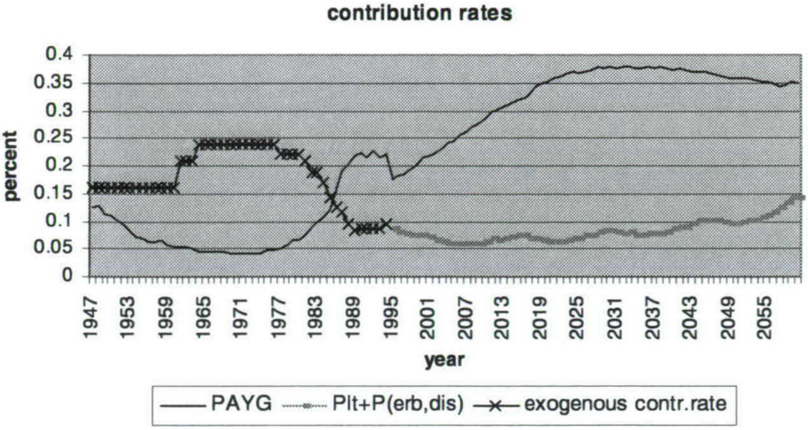

Figure 6.11

1947 is caused by the fact that the 'starting number' of old-age pension beneficiaries was exogenously set, with those individuals actually becoming beneficiaries being selected by using entry rates based upon an exogenous age-distribution of the civil servants. As a consequence, its development in the first quarter of the simulation period is rather unreliable. The discontinuities which the PAYG-premium shows around 1995 are probably caused by the change of the exemption, from being a function of the AOW, to a fixed amount of money (26,500 guilders in 1995). From that year on, the PAYG-premium shows a stable development over time, increasing up to almost 34% in 2035 and afterwards. Even though the number of old-age pension beneficiaries does not reach its peak a couple of years later, the number of WW&O-pension beneficiaries does. Moreover, the number of active participants (which was increasing, though considerably slower than the pension-beneficiaries) reaches a maximum and stabilizes. Some discontinuities of the fictitious PAYG-contribution rate in the starting year 1947 and around 1995 were somewhat awkward, but the fact that it is considerably below both the base-rate premium (figure 6.10) and the exogenous historical contribution rate and, secondly, its slow increase over time after 1995, is what would have been expected. The actuarial contribution rate does not show this increase over time , which is a direct result of its dynamic nature: the number of pension beneficiaries relative to the number of contributors of course does not affect this contribution rate, or at least not as much as in the case of the PAYG-premium. A last observation which should be made is that the PAYG-contribution rate remains above the dynamic contribution rate for the whole simulation period, a difference which can be explained by referring to the discussion on the relative efficiency of PAYG and CF- pension schemes, as presented in the first part of this study.

Up to now, the fund-wide simulation results of the base-variant were presented and discussed. In this variant, the pension fund ABP was simulated, using a final-wage scheme, an exogenous contribution rate before 1995 and an endogenous contribution rate afterwards, and an assumed development of the return on investment as shown in figure 5.14.

This study disentangles a couple of simulation variants, which will be presented and discussed using the base-variant as a reference. The first simulation variant of which the fund-wide simulation results are to be discussed next, consist of the pension fund model as just described, but then with a transition from a final-wage system to an average-wage system in the year 2000. As an illustration, the situation where this transition will occur in 2025 will be considered as well. This last situation will, however, be considered when discussing the lifetime simulation results.

Let us recapitulate briefly what happens in the case of such a transition in a certain year: before that year, the pension claim accumulated over the past years is a function of the final wage. From that year on, the newly accumulated pension claim is a function of the (lower) average wage. So, after the transition year, the aggregated pension claim should slowly decrease relative to its development if the transition did not occur. Figure 6.12 shows the development of the aggregated actuarial pension claim in the case of no transition and a transition in 2000, respectively 2025.

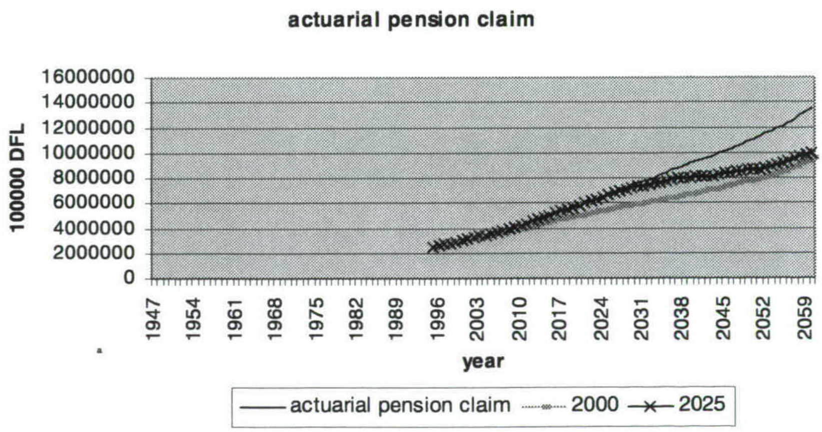

Figure 6.12

The gradual lagging of the aggregated actuarial pension claim as a result of the transition is easily seen. Moreover, the courses of the two latter variables seem to converge and the speed at which they move away from the development in the case of no transition, decreases. So, a transition from a final-wage scheme to an average-wage scheme causes the aggregated actuarial pension claim to shift to a lower but parallel level. The year in which this transition occurs does not seem to affect the ultimate level of the actuarial pension claim (that is why both series converge), though it affects about when the stabilization emerges, of course. In fact, both series converge to the development of a fictitious pension fund which has had an average-wage scheme from the first year on, and which consequently has no participants facing a pension based on the final-wage scheme. To explain all this, let us start by comparing two pension schemes, one adopting the final-wage scheme and the other using the average-wage scheme, but which are otherwise identical. As the wage-base is the only difference between both funds, the aggregated actuarial pension claim of the pension fund will be below that of the 'final-wage-pension fund', but its development over time will be the same. It can be seen that the actuarial pension claim given a transition in 2000 and 2025 gradually converges to this new and lower level. As time goes by, the year in which the transition occurs shifts further into the past. Put differently, the number of years over which a future pension claim based on the final wage was calculated decreases relative to the number of years which add to the future average-wage-pension benefit. Eventually, all civil servants who experienced the transition will retire, die or otherwise cease to be a civil servant. From that year on, actuarially speaking, it would be as if the final wage system never existed and the actuarial pension claim will therefore have reached its new stable level.

Now what is the effect of a transition from a final wage-system to an average wage-system on the development of assets of the ABP? As the actuarial discounted future pension claim decreases, the amount of money needed to cover this pension claim will decrease as well. In other words, the fact that the actuarial pension claim decreases will cause assets to decrease as a result of a decreasing contribution rate. This decreasing contribution rate is clearly seen in figure 6.13. This figure shows the long-term contribution rate, being the function of the actuarial

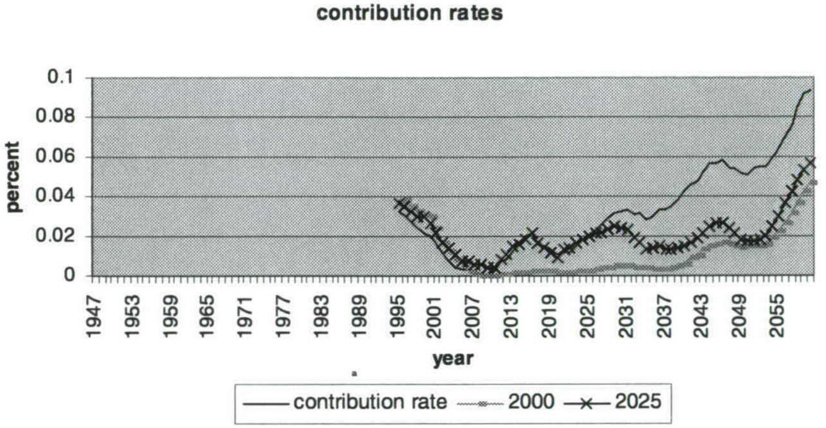

Figure 6.13

pension claim, the (unchanging) pension base and assets. Note that the PAYG-contribution rate used for the financing of ERB (early retirement benefit) and disability pension benefit is not given since these pension benefits remain unchanged. The effect on the development of assets is shown in figure 6.14: as a result of the imposition of the average-wage scheme, assets decrease relative to their development if the final wage-scheme would have persisted. Moreover, as the actuarial pension claim given the transitions in 2000 and 2025 do, the course of assets converge. It is however striking that the decrease of assets resulting from the transition is not very important. Especially in the case of the transition in 2000, one would have expected a more prompt effect on the development of assets relative to the 'no-transition'-situation. This shows the importance of investment results on assets, an importance which is greater than that of the contribution rate.

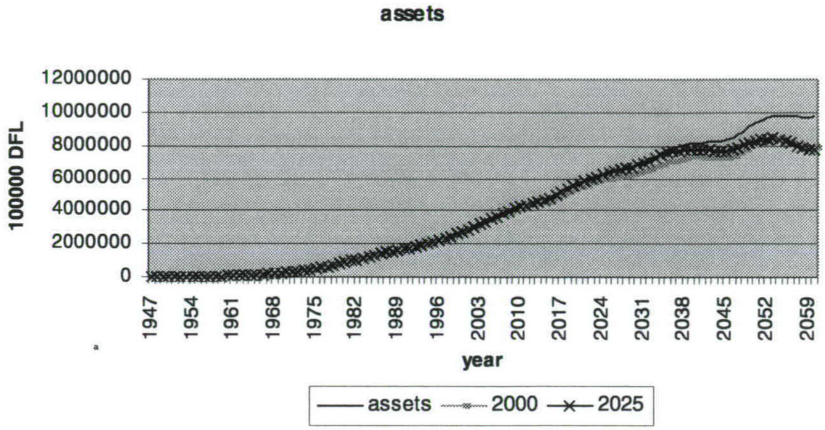

Figure 6.14

Here ends the presentation of the fund-wide simulation results for the base-variant. Next, we consider the lifetime income simulation results which stem from the pension fund ABP.

6.2. Lifetime simulation results.

Introduction.

In the previous paragraphs, the fund-wide simulation results of the base-variant (i.e. without a transition from a final wage scheme to an average wage scheme) and a variant where this transition occurs in 2000 were presented and discussed. In this paragraph, the simulated lifetime incomes of the four subsequent generations of participants in the fund will be presented and discussed. For a thorough discussion of what lifetime income exactly is and how it is derived, the reader is referred to paragraph 3.3. It will be argued there that lifetime income is the summation of the discounted annual semi-household income which adult individuals in the household have gathered over their lifetime.

Next, we present and discuss the simulation results. First of all, the simulation results of the base-variant will be the subject of our attention. After that, the effect of a transition from a final wage scheme to an average-wage on the redistribution of lifetime-income will be considered. The simulation results which stem from simulation variants will be compared to the results from this base-variant.

6.2.1. The base-variant.

As said, the point of departure of this study is the lifetime household-income of four subsequent generations of civil servants. The 1930-generation was born between 1930 and 1935. For the other generations, the name used to refer to them denotes the middle-year of the birth period. So, the members of the 1940-generation are born between 1936 and 1945, the members of the 1950-generation are born between 1946 and 1955 and, lastly, the members of the 1960-generation are born between 1956 and 1965. For all individuals in these generations or birth-cohorts, the entire life histories are simulated by the model. Table 6.1 shows the discounted, equivalent and individual lifetime-income results of the base-rate simulation, where the contribution rate is exogenous before 1995 and where there is no transition from a final-wage scheme to an average-wage scheme. In the above table, the standard errors are included. This is done to emphasize that these figures are averages of 15 runs, thereby introducing Monte Carlo variance. For a more elaborate discussion, see appendix 4. This Monte Carlo variance will allow us to consider the significance of changing lifetime incomes, contributions and benefits. One should therefore bear in mind that these simulation results can be affected by outliers and such. By dividing the total number of years by the number of individuals on which the figures in the above table are based, we can see that the average career-length is about 16.3 years for the 1930 generation. For the other generations, this is 15.7, 13.6 and 12.1[49].

The simulation results in the following table -and others yet to come- are expressed in so-called 'yearly income', whereas we said lifetime-incomes were simulated; this might cause misunderstanding, so it will be explained in brief. By 'yearly income' or 'yearly contributions' we do not mean annual income or contributions, i.e. received or paid in a certain year, but lifetime income divided by the full number of upbuilding years (which is not the same as the years during which the individual has been a civil servant). For instance, if an individual has

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[49]Of course, these figures are not discounted. Any comparison with actual annual figures is rather tricky, but the fact that the statistical appendix of the 1992-annual report of the ABP (table 1.9, p.12) shows an average length of career of 14.04 and 14.63 in 1990 and 1991 respectively, is encouraging in the sense that there does not seem to be persistent over- or underestimation. Moreover, these differences seem limited.

been a civil servant for 30 years and an ERB for 4 years, then his discounted lifetime income is divided by 30+.5*4=32. In these tables, the average discounted lifetime figures are divided by the number of 'career-years'. This way, figures are corrected for the (decreasing) average length of the career. So, 'gross yearly wage as civil servant' could loosely be interpreted as 'the average equivalent annual wage which the individual received over his career as a civil servant, in guilders of 1992'. Unfortunately, this means that the above figures cannot be compared directly with actual 1992 pension benefits, since the above figures are discounted to 1992 and not divided by their respective numbers of beneficiaries, but by the numbers of civil servants instead. So, a relatively high pension benefit which is paid out to a relatively low number of individuals, such as the disability pension benefit, will in yearly terms be far lower than the actual average pension benefit. Moreover, conclusions on the comparison of the level of various pension benefits are difficult to draw either, since both the levels of benefits and the proportion of beneficiaries differ. The way in which the simulation results are expressed is purely a function of the research problem. When the goal is to analyze the redistribution of income between generations, it is not interesting to see how important the early retirement benefit is to its beneficiaries, for instance. What interests us is to see how important the early retirement benefit is *for an entire generation of civil servants*. Again, a benefit which is paid to a few civil servants is not very important, even if the actual benefit paid out would be very high, since it does not add up significantly to the income of the entire generation. Put differently, what the figures show is the relative importance of the pension benefit for the various generations.

Let us start the discussion of the above table 6.2 by noting that the average equivalent annual wage increases over generations, despite of the fact that the income figures are discounted for changes in the macroeconomic wage index. A likely cause for this development is the increasing average age of civil servants, which results in non-incidental increases in the macroeconomic wage (wage-thrift). Note that these increases are the most significant between the first and second, and third and fourth, generations. As the equivalent old-age pension benefit is a function of the (final) wage, the fact that the yearly equivalent old-age pension benefit follows more or less the same pattern, is not unexpected[50]. When the various pension benefits

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[50] Note that the growth rate of the old-age pension benefit is considerably higher than that of the yearly wage as a civil servant, at least between the first and the second and the second and third generations. This higher growth rate for the old-age pension benefit is probably caused by the exemption, which decreases relative to the wage-level and which therefore becomes less important over time. Of course, this does not hold for the last generation, since the exemption was replaced by

are compared, it can be seen that the old-age pension benefit and WW&O-pension benefit are more important than the disability pension benefit and -especially- the early retirement benefit (ERB). This is true even though the last two are a direct function of the last-earned wage, without taking the total upbuilding into account (the latter is also the case for the WW&O-pension if the claimant deceases while being a civil servant[51]). The conclusion is therefore that it is not so much the average level of benefit but merely the number of beneficiaries wich determines the importance of a pension benefit for a generation. When turning to the contributions, notice that the model distinguishes employees' and employers' contributions. It is assumed that these two groups cover 25% and 75% respectively of the total annual contribution. The fact that employers' and employees' contributions have been distinguished in table 6.2. is merely for purposes of presentation. This distinction is only made to highlight the fact that only since the individual labour supply takes only the net income (i.e. income after taxes and employees contributions) into account. However, when comparing benefits with contributions, we will take employers and employees contributions together. So, in the tables from table 6.2 onward, this distinction will not be made.

When considering the contributions, note that the old-age and WW&O-contributions are considerably higher than the disability and ERB-contributions. This is not very surprising. First of all, the exogenous contribution rate prior to 1995 is entirely an old-age and WW&O-contribution rate, which also explains why the increase of the disability and ERB-contribution rate over generations is considerably stronger than that of the old-age and WW&O-pension benefit. Secondly, the difference in contributions is caused by the difference in benefits, meaning that the old-age and WW&O-pension benefits are considerably higher than the disability pension benefit and ERB. Lastly, note that the total PAYG-contribution rate is higher than the total Capital Funding contribution rate for the 1940, 1950 and 1960-generations. However, for the first generation, the 1930-generation, the situation is the opposite. It appears that a PAYG-system would have been more efficient for the first generation as it would have shifted the cost of its pension largely to the other generations (see the Aaron-variable in chapter 2).

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an indexed guilder-value (26,000 in 1995) from 1995 onward.

[51] Remember that the beneficiary of a WW&O-pension benefit, the individual who actually receives the benefit, is not the same as the civil servant who gathered the pension claim in the past. In fact, it is the partner of the deceased civil servant.

Table 6.1. Lifetime income results in 1992-guilders. Base-rate simulation*.

generation	1930	1940	1950	1960
no of years	3779.35	6574.40	8980.25	8955.90
-- St.Err. --	106.38	108.86	92.98	151.25
no of individuals	231.70	419.70	660.90	737.90
-- St.Err. --	4.80	4.28	7.19	13.99
gross yearly wage as civil servant	40588.10	47617.40	52963.60	58440.70
-- St.Err. --	674.61	507.38	465.01	456.16
total yearly old-age pension benefit	7752.40	10959.10	13397.40	14252.20
-- St.Err. --	411.17	426.35	242.46	234.71
total yearly disability pension benefit	2779.80	4282.80	4467.80	3597.90
-- St.Err. --	314.24	460.14	322.50	300.47
total yearly WW&O pension benefit	6846.20	7073.90	8445.80	11079.10
-- St.Err. --	1433.32	825.21	592.91	700.93
total yearly ERB	1346.20	891.70	930.00	1047.40
-- St.Err. --	115.51	36.50	35.92	37.01
total yearly benefit	18724.70	23207.70	27241.20	29976.50
-- St.Err. --	1735.45	1017.91	682.09	953.41
total yearly employees' contributions (old-age and WW&O)	1145.90	1166.20	1159.90	1249.40
-- St.Err. --	25.51	22.50	38.42	55.86
total yearly employers' contributions (old-age and WW&O)	3438.30	3499.10	3479.60	3748.50
-- St.Err. --	76.55	67.48	115.29	167.64
total employees' contributions (disability and ERB)	46.10	243.70	450.90	619.80
-- St.Err. --	4.38	8.70	12.07	18.59
total employers' contributions (disability And ERB)	85.50	452.50	837.30	1150.90
-- St.Err. --	8.14	16.06	22.42	34.47
total contributions	4716.20	5361.60	5927.10	6768.70
-- St.Err. --	108.31	99.42	172.46	246.02
Employees' contributions (PAYG)	990.90	1406.40	2056.10	3004.00
-- St.Err. --	43.32	29.85	48.46	51.05
Employers' contributions (PAYG)	2900.90	4253.50	6207.20	9061.90
-- St.Err. --	126.04	89.81	146.91	156.52

* Discounted lifetime income figures, corrected for the wage-index and divided by the individual's number of upbuilding years were added up for all individuals in the generation and then divided by the number of civil servants in the generation. Consequently, the results are corrected for systematic differences of (a) the career-length of civil servants and (b) the relative number of civil servants. These figures therefore reflect the importance of the various benefits and contributions for a generation as a whole. .

When expressed in percentages of the gross yearly wage as a civil servant (the seventh row), we can consider the development of the importance of the various pension benefits (in terms of how much they add to the lifetime income) over time, since the effect of the incidental development of wages (wage-thrift) is neutralized as well. For the four generations and the four relevant pension benefits, these figures are shown in table 6.2.

Table 6.2. Pension benefits, as a percentage of the gross yearly wage, base-rate simulation*.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	19.10	23.01	25.30	24.39
total yearly disability pension benefit	6.85	8.99	8.44	6.16
total yearly WW&O pension benefit	16.87	14.86	15.95	18.96
total yearly retainment pay	1.78	1.91	1.94	1.88
total yearly ERB	3.32	1.87	1.76	1.79
total yearly benefit (ex. Ret.pay)	46.13	48.74	51.43	51.29

* See table 6.1, but figures are also corrected for the importance of the lifetime civil servants wage, so that the effect of ageing on wage-thrift is taken out.

Note that the standard errors which stem from the 15 runs are not included, since these figures in table 6.2. are not directly generated by the model, but are derived from table 6.1. In the case of the old-age pensions, expressing the benefit as a percentage of the gross wage does not reveal very much we did not know before. The importance of this benefit is gradually increasing, at least for the first three generations. The increase between the 1930- and 1940-generations is particularly considerable. The relative yearly disability pension benefit increases between the first and the second generation and decreases afterwards. It appears that the increasing number of disability pension beneficiaries, as presented in figure 6.3, belong mainly to the 1940 and 1950-generations. The development of the relative yearly WW&O pension benefit over generations is somewhat awkward, which is mainly due to the low relative benefit for the 1940-generation. This in turn is caused by a slow increase of the numerator, the lifetime guilder-value of the WW&O-benefit (from 6846 to 7073 in table 6.2), combined with a strong increase of the denominator, the lifetime civil servant's wage. The relative importance of the early-retirement benefit is very much as expected, by contrast. This scheme is the most important for the first generation, and decreases afterwards. This development is caused by the development of the numbers of beneficiaries over time, as shown in figure 6.5. The high number of early retirees at the end of the eighties and beginning of the nineties seems to have been mainly members of the 1930-generation, which is not very surprising, since the oldest members of that generation reached the age of 60 in 1990. Note again that the disability pension benefit is considerably more important than the ERB for the four relevant generations, even though the actual individual ERB as a fraction of the wage of the civil servant is higher than the disability pension benefit. The reason for this is that there are more disability pension beneficiaries than ERB-beneficiaries. The last row of table 6.2. shows the total yearly relative pension benefit. the total pension benefit for the subsequent generations is about 46 and 49% of the gross yearly wage for the first two generations, and 51% for the last two generations. It is clear that the development of the relative total yearly benefit is to the largest extent caused by the development of the yearly old-age pension benefit.

Of course, generations not only receive money from the pension fund, they contribute to it as well. Table 6.3 shows the total pension contributions as a percentage of the gross yearly wage.

Table 6.3. Pension contributions, as a percentage of the gross yearly wage, base-rate simulation

generation	1930	1940	1950	1960
total yearly old-age and WW&O-pension contribution	11.29	9.80	8.76	8.55
total yearly disability and ERB- contribution	0.32	1.46	2.43	3.03
total yearly contribution	11.62	11.26	11.19	11.58

The relative value of yearly total contributions remains stable over the four distinguished generations, a development which is clearly determined by the countering developments of the old-age and WW&O-pension contribution, on the one hand, and the disability and ERB-contribution on the other hand. The most striking aspect of this is the high per-guilder contribution of the 1930 generation to the old-age and WW&O-pension schemes, accompanied by a very low contribution to the disability and early retirement pension schemes. The second observation is caused by the fact that no separate contributions for the disability and ERB were made. The first observation of course is caused by the high exogenous contribution rate which existed during the sixties and seventies. It is true that this contribution rate decreased during the eighties, but then the members of this first generation were already in their fifties. As a result, they did not benefit as much from this decreasing contribution rate as the second and third generations did. Moreover, the early years were more upwards discounted than the later years. Of course, the 1940 generation has been contributing according to this exogenous contribution rate as well, but for a fewer number of years, and -as they were younger during the period that the high contribution rates applied- over a lower income than the members of the 1930 generation. That the ERB- and disability pension contribution rates are considerably lower is not surprising, since the amounts of money involved in these schemes are lower than those involved in the old-age and WW&O-pension schemes. The second reason for the increasing disability- and ERB contribution rate, which applies for the last two generations, is that these disability pension benefits and ERB are financed through PAYG. So, the important increase in the number of early retirement beneficiaries during the eighties is not financed by these individuals themselves, but by individuals who where civil servants at that time, and who most likely were younger. This means that the cost of these pension schemes was shifted to the future, causing an increasing relative contribution for the last two generations.

To summarize, the relative old-age and WW&O-contribution rate increases over generations, whereas the disability- and ERB-contribution rate increases strongly over the generations. However, as the latter is by far less important than the former, the total yearly 'lifetime-average' contribution to the pension fund decreases over generations. Before ending the discussion of this table 6.3 a last brief remark to be made is that the comparison of the figures in this table shows that the benefits obtained by generations from the pension fund are considerably larger than the contributions which they made to the fund. This shows the effect of the real rate of return on investments which the model generates. In fact, it is the result of this rate of return being higher than the macroeconomic wage thrift[52].

In the last paragraphs, pension benefits and -contributions have been discussed separately. The next logical step is then to consider the net-pension benefit, or the difference between contributions and benefits, both expressed in equivalent 1992-guilders and in percentages of the gross yearly wage of the four generations. These figures are seen in table 6.4. When considering the 1992-guilder values in this table 6.4, the earlier conclusion that the old-age and WW&O-pension benefit adds up the most to the lifetime income of the various generations, is strongly supported. Moreover, this importance increases over the generations, which is caused by the decrease of the proportional disability- and ERB- schemes relative to the importance of the WW&O and -especially- the old-age pension scheme.

[52] This is not the same as the Aaron-variable as presented in paragraph 2.3. The Aaron-variable compares the two basic pension schemes, CF and PAYG, and is therefore determined by the difference between, on the one hand, the real rate of return on investment and, on the other hand, the macroeconomic wage thrift plus the population growth.

Table 6.4. balance of benefits and contributions, in 1992-guilders and as a percentage of the gross wage.

generation	1930	1940	1950	1960
old-age and WW&O-pension benefit	10014.40	13367.70	17203.70	20333.40
disability pension benefit and ERB	4086.60	4965.70	5011.40	4114.20
total	14101.00	18333.40	22215.10	24447.60
old-age and WW&O-pension benefit	24.67	28.07	32.48	34.79
disability pension benefit and ERB	9.84	9.40	7.76	4.92
total	34.51	37.48	40.24	39.71

This pattern becomes even more visible when considering the net benefits expressed as percentages of the gross yearly income of that generation. Here, the net benefit which the generations get from the old-age and WW&O-scheme increases from 24.7% for the 1930 generation to more than 34% for the 1960 generation. As opposed to this, the relative net benefit coming from the disability and ERB-scheme decreases from almost 10% for the 1930 generation (caused by the low contributions) to a bit less than 5% for the 1960 generation. This shows the intergenerational redistribution of these schemes, caused not only by the PAYG-financing of these benefits (at least from 1995-onward), but also by the fact that the ERB benefits mostly the 1930 generation. So, on the whole, the last two generations gain considerably more from the pension fund than the first two generations. This is again caused by the net benefits from the old-age and WW&O-pension schemes.

Having discussed the above figures, what can be said about intergenerational redistribution of income through the pension fund ABP? This question has been dealt with in paragraph 3.3, and involves the fact that there is no intergenerational zero-sum-game. So, the gains and losses of the generations do not cancel each other out, and would therefore reflect intergenerational redistribution of income. For illustrative purposes, and following a somewhat Rawlsian- or minimax-view on welfare, the average per-guilder gain is subtracted from the actual gain of every generation, thereby imposing a zero-sum-game: any gain which a generation gets above this level is 'covered' by a equivalent loss for other generations. As said in paragraph 3.3, this subtraction does not alter the pattern of profits, so its informational value is limited, but the relative sizes of gains and losses become more emphasized. Figure 6.15 shows the known pattern of 'winners' and 'losers' in the case of this 'above-average profit': the 1950 generation and -to a lesser extent- the 1960 generation gain at the expense of the 1930 generation.

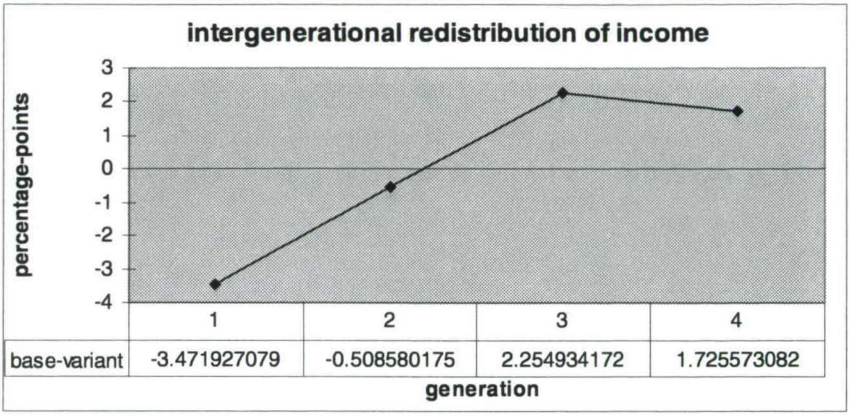

Figure 6.15

Here ends the discussion of the base-variant for generations as a whole. We have started this first part of chapter 6 by considering the simulation results of various categories of participants in the pension fund, as well as the development of assets, the actuarial pension claim and the contribution base. The fit between the simulation results and the historical data is good for the most important variables. The endogenous contribution rate decreases relative to its 1995 value at first, but a steady increase sets in from about 2008 onwards. As a result, and driven by the real rate of return, assets increase steadily over the simulation period, though the speed of this increase decreases very slowly. But of course, the most important information in this first part of chapter 6 concerns the intergenerational redistribution of income through the pension fund ABP. This does not follow directly from the simulation results, since every generation gets more out of the pension fund than they contributed to it and since the four generations do not stand alone: other -unobserved- intergenerational redistribution exists. However, imposing a zero-sum-game by introducing an 'average gain per guilder' which is the same for all generations, shows that the 1960 generation and especially the 1950 generation gains considerably, a gain which implicitly takes place at the expense of the 1930 generation in particular. This pattern is for the most part caused by the net benefit which the subsequent generations get out of the old-age and WW&O-pension schemes. Especially, this suggests the important role of the exogenous contribution rate which was imposed upon the ABP by the Minister for Social Affairs before 1995, the year the ABP became independent. The fact that the older generations gain more from the disability and ERB pension schemes than the younger generations is not important enough to neutralize this pattern caused by the old-age and WW&O-schemes. Only the somewhat higher per-guilder gain which the 1950 generation gets out of the pension fund, as compared to the 1960 generation, is caused by the higher disability and ERB pension benefits of this generation, as compared to the 1960 generation. It is for this reason that the 1950 generation becomes the 'winner' of this zero-sum game, with the 1930 generation as the main 'loser'.

Next, we will consider the effect of the transition from the final wage-scheme to an average-wage scheme on the lifetime-incomes of various generations, and on the two methods reflecting intergenerational redistribution of income as discussed above. After that, we will turn back to the base-variant, where we will then consider various subgroups within the four generations.

6.2.2. The effect of a transition from a final-wage scheme to an average-wage scheme on lifetime incomes.

Next, let us consider what happens if the pension scheme shifts from a final wage-system to an average-wage scheme. This change is implemented by itself, i.e. without changing any other variables in the scheme. In a number of cases where policy-makers and representatives of pension funds discussed such a transition, it was often accompanied by a change (increase) of the annual upbuilding percentage. This way, the negative effect of a shift to an average-wage scheme would to a certain extent be neutralized by the increasing pension claim as a percentage of the (lower) wage-base (see WRR, 1999, paragraph 6.2.2.). In this model, this has not been done. The reason for not doing so is that the model is not able to properly simulate a joint and countering change of the wage-base and the upbuilding percentage. This will be explained extensively in appendix 3.

In table 6.5 the simulation results, given that such a shift occurs in 2000, are presented. To facilitate the comparison with the base-variant, these simulation results were first calculated as a percentage of the gross yearly wage, and then expressed in relative differences of the benefits or contributions as a fraction of the gross yearly wage in the case of the base-variant. So, a value of 100 means that the benefit or contribution as a percentage of the gross yearly wage remains unchanged as a result of the transition from a final wage scheme to an average wage scheme.

Table 6.5. Effect of a transition from a final wage scheme to an average wage scheme in the year 2000.

generation	1930	1940	1950	1960
benefits				
total yearly old-age pension benefit	99.51	98.16	86.90	76.36
total yearly WW&O pension benefit	105.14	90.27	90.83	74.8
total yearly benefit (incl. dis. & ERB)	104.97	99.23	89.31	68.9
contributions				
total yearly old-age and WW&O-pension contribution	100.34	99.79	91.70	76.66
total yearly contribution (incl. dis. & ERB)	100.19	97.92	90.05	79.14
balance of benefits and contributions				
old-age and WW&O-pension benefit	102.98	99.53	91.36	77.31
total	106.58	100.58	96.66	89.76

We would expect the old-age pension benefit and the WW&O-pension benefit of all generations except the 1930 generation to decrease as a result of the shift from a final wage-scheme to an average wage scheme. By contrast, the disability pension benefit and early retirement pension benefit are not pensions in the actuarial sense of the word: they are not a function of the expected final or average wage at 65, but are a function of the wage in the last year(s) before becoming an early retirement beneficiary or disabled. Consequently, these benefits are not affected by the transition from an average wage scheme to a final wage scheme. For this reason, these benefits (and the accompanying contributions) are not included in table 6.5.

Bearing this in mind, let us consider table 6.5, where the effect of a transition in the year 2000 is shown. For instance, in this table, the yearly lifetime old-age pension benefit as a percentage of the lifetime civil servant's wage in this second variant (i.e. given a transition in the year 2000) is divided by the same number in the base variant (as presented in table 6.2). It is not very surprising that the transition from a final-wage scheme to an average wage scheme causes the old-age benefit to decrease relative to the base-variant. The first line of data in table 6.5. shows that this is the case for the last two generations. For the 1950 generation, the lifetime yearly old-age pension benefit decreases to about 86% and for the 1960 generation, the relative benefits ends up at no more than 76%. As the number of WW&O-pension beneficiaries is relatively low, the variance of the lifetime WW&O-pension benefit is higher than that of the old-age pension benefit (see table 6.1). So, it can be expected that the differences with the base variant are larger and that the pattern of this lifetime benefit over generations is more discontinuous, as compared to the lifetime old-age pension benefit . This is confirmed by table 6.6.

Table 6.6. T-value for the effect of a transition from a final wage scheme to an average wage scheme in the year 2000.

generation	1930	1940	1950	1960
gross yearly wage as civil servant	-0.04	-0.10	-0.86	-0.20
total yearly old-age pension benefit	-0.07	-0.32	-4.12	-8.57
total yearly WW&O pension benefit	0.13	-0.41	-0.81	-2.42
total yearly benefit	0.27	-0.58	-2.62	-5.58
total yearly contribution	0.02	-0.22	-2.09	-3.77

For the 1930 generation, the lifetime WW&O-pension benefit ends up about 5% higher. But this situation does not last very long: for the 1940 generation, the WW&O-pension benefit all of a sudden ends up 10% lower than in the case of the base-variant. Fortunately, for the last two generations, the differences are less discontinuous. Actually, the percentages end up comfortably close to those of the old-age pension benefit. Apart from the over-simulation of the lifetime benefit for the first generation, the relative yearly WW&O-pension benefit roughly shows the same pattern over generations.

Next, we consider the development of the contributions. As the transition occurs in the year 2000, the contribution rate before that year remains unchanged (not to mention the fact that the pre-1995 contribution rate is exogenous). From that year on, figure 6.13 shows that the contribution rate for the old-age and WW&O-pension benefit decreased relative to its 'original' level. This decrease is a logical consequence of the decreasing actuarial pension claim. So, we would expect a decreasing relative lifetime contribution to the old-age and WW&O-scheme, at least for the 1950- and 1960 generations. This expectation is met in table 6.5: for the first two generations, the contributions to the old-age and WW&O-scheme in the case of a transition to an average wage scheme differ hardly from those in the case of the base-variant. For the 1950- and 1960 generations, however, the contributions end up lower. Especially for the last generation, this decrease is quite important, as figure 6.13 shows that the difference between the contribution rates becomes quite important. Note that these relative figures are very close to those of the old-age and WW&O-pension benefit.

So far, we have not included the Monte Carlo variance in our analysis of the effects of a change of the wage-base in the year 2000. Are these changes significant, or are they simply the result of this Monte Carlo variance? As the simulations are based upon randomly selected starting values, we can use t-values to answer this question. Table 6.6 on the previous page shows the T-values of the difference between the lifetime values of both schemes in the base-variant and this variant, where a transition takes place. So, a negative value means that the lifetime guilder value decreases and the more this value differs from zero, the less it is likely to be caused by Monte Carlo variance. The conclusion which can be drawn from table 6.6. is that the change from a final wage scheme to an average wage scheme has no significant effect on the old-age and WW&O-pension benefit of the first two generations. For the 1950 generation, the lifetime old-age pension benefit decreases significantly, but the decrease of the WW&O-pension benefit is unclear. However, for the 1960 generation, the decrease of both the old-age pension benefit and the WW&O-pension benefit seem to be caused by the transition of wage-schemes.

So, both contributions and benefits decrease as a result of the transition to an average-wage scheme. The last rows of table 6.5 however shows clearly that the balance of benefits and contributions in the case of such a transition to an average-wage scheme in 2000 end up considerably lower than in the base-variant, at least for the 1960 generation. What effect this will have on the distribution of the above-average profit patterns over generations (which we adopted as depicting the implicit redistribution of income over generations) is not difficult to guess: the 1960 generation in particular, will lose considerably relative to the other generations. The average relative net profit for these four generations, of course, decreases as well as a result of this (from 37.9% to 33.6% actually) and at least one of the other generations will by definition gain relative to the situation where there is no such transition to an average wage scheme. This is confirmed by figure 6.16: the 1960 generation loses considerably, with the result that the 'intergenerational position' of the other generations relative to this last generation, is improved. The position of the 1930 generation especially improves quite considerably in relation to the other generations. There are two reasons for this. First of all, the old-age pension benefit is the least affected by this transition to the average-wage scheme. But as the position of the younger generations (especially the 1960 generation) deteriorates, the position of the 1930 generation improves.

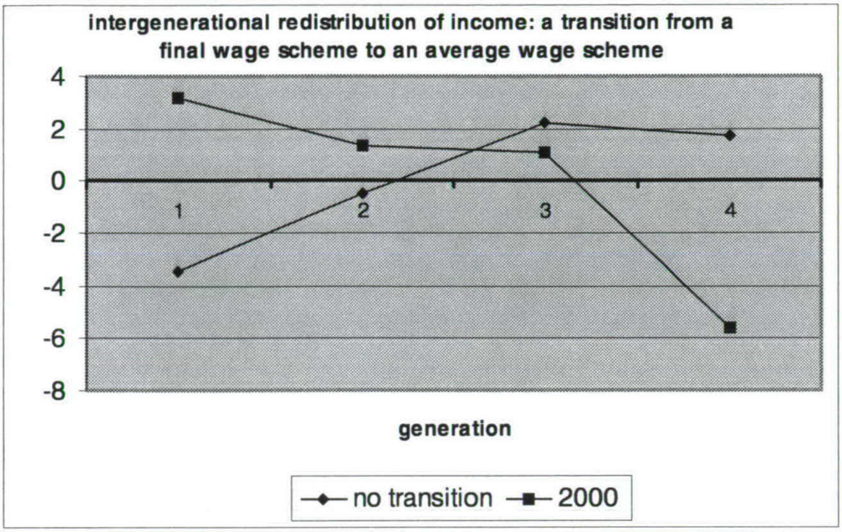

Figure 6.16

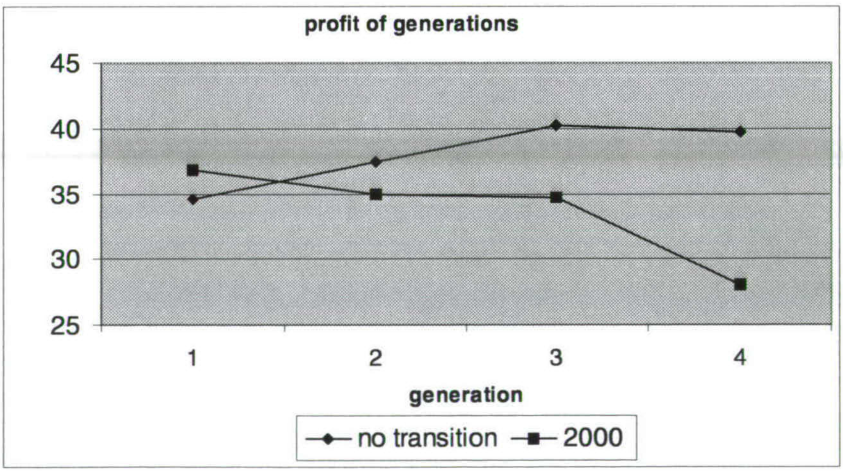

Figure 6.17

This reveals that the imposition of a zero sum game makes comparison between variants somewhat tricky, in the sense that this zero sum game which underlies the depicted patterns of intergenerational redistribution of income, causes some generations to become 'winners' even if their net lifetime profit which they gain from the pension fund does not increase or even decreases. This is the case if the decrease in the net lifetime profit is smaller than average. In this case, other generations suffer more than this generation does, with the result that this generation becomes a 'winner'. Put differently, questions like "which generation gains and which loses *in relation to other generations*" can be answered using figure 6.16. On the other hand, questions such as "which generation gains and which loses" should be answered using figure 6.17, where the profit which each generation makes by participating in the pension fund, is depicted. Remember that the difference between the profits depicted in figure 6.17 and the intergenerational redistribution shown in figure 6.16 is that the latter is equal to the former, minus the average profit for the four generations. Here it is shown that the effect of the transition on the first two generations is unclear. Especially the higher profit of the 1930 generation is caused by an increase of the disability and ERB-benefit, in turn caused by Monte Carlo variation. However, the effect is that the position of this 1930 generation in terms of the intergenerational redistribution of income as shown in figure 6.16 increases more than it should have done. This does not, however, change the conclusions based upon figure 6.16. For the last two generations, figure 6.17 shows clearly that their profit deteriorates. Especially for the 1960 generation, the profit decreases with almost 42% from 39 to 28% of gross lifetime wage.

To summarize, by transiting to an average-wage scheme in 2000, the overall figure changes considerably. Even though all generations still gain from their participation in the pension fund, figure 6.17 shows that the youngest generation now gains considerably less than all other generations. Put in terms of intergenerational redistribution, shown in figure 6.16, a transition to an average-wage scheme would cause intergenerational redistribution of income from the youngest generation to the oldest generation (i.e. the 1930 generation). So, as compared with the original situation where there was redistribution of income (or, to be precise, gain) from the oldest two generations to the youngest generation, the situation is reversed. But why is this? For the decrease in future actuarial pension claim was accompanied by a rather large decrease in the contribution rate. It appears that the contribution rate could have decreased even more if the 1960 generation would not have had to cover a part of the pension claim of the other generations (whose claim did not change as much as a result of the transition from a final-wage scheme to an average wage scheme). So, for this 1960 generation, the lifetime contributions did not decrease as much as the benefits did.

In the beginning of this paragraph, we said that the effects of the transition from a final wage scheme to an average wage scheme in the year 2025 would not be expressed in terms of lifetime income. For, as the effect of this transition emerges only slowly, the lifetime benefits and contributions of any of the relevant generations would remain unaffected by this measure, so its information value would be very limited.

Before ending this paragraph, let us dwell a bit longer on these patterns of above-average profit. It was concluded that, in the base-variant, the oldest generations (i.e. the 1930 generation) obtain a considerably lower profit out of the pension fund than the last two generations. Using the concept of average generational profit -which is based on the notion that this average profit represents the case of no redistribution of income between generations- the conclusion was drawn that there was redistribution of income from the oldest generations to -especially- the 1950 generation. The strength of the effect of the transition from a final wage-scheme to an average-wage scheme depends on the year in which this transition takes place, the earlier in the simulation period, the stronger the effect on the lifetime-incomes of subsequent generations is. In the case of such a transition in the year 2000, the pattern of intergenerational redistribution changes completely. In this case there would be implicit intergenerational redistribution from the last (1960) generation to the first (1930) generation, meaning that the latter generation would now have a below-average-profit, whereas the profit of the former would become higher than average. So, the result of the transition from a final wage scheme to an average wage scheme, would be that the 1950 generation would no longer be the winner of the zero-sum game (in the sense that the above-average profit would be the highest), but this position would be taken by the oldest (1930) generation. As the net pension benefit of this generation is not affected by this transition (see figure 6.17), it is clear that this pattern is caused by the fact that the average generational profit is higher in the base-variant than in the case where the transition takes place in 2000.

6.2.3. Distinguishing the generations: gender and education.

In this paragraph, we will basically do the same as we did in the preceding paragraphs, but now a distinction will be made between men and women. As in tables 6.5 and 6.6, the income figures will be expressed as a percentage of the gross lifetime civil servant's wage. However, it would not be very useful to express the numbers of both men and women as a fraction of the generation-wide number, as both categories are mutually exclusive. Rather, the figures show the numbers for women expressed as a percentage of the same number for men. This way, the relative differences between the sexes are highlighted in just one table.

Table 6.7: lifetime incomes of women, as a percentage of that of men, base-variant.

generation	1930	1940	1950	1960
number of individuals	62.03	64.33	82.77	87.81
career length	30.16	34.69	53.59	64.45
gross yearly wage as civil servant	93.31	100.26	82.21	82.4
benefits				
total yearly old-age pension benefit	102.66	102.63	80.85	89.74
total yearly WW&O pension benefit	3947.37	2183.22	1070.38	586.88
total yearly benefit	220.49	184.49	141.52	156.42
contributions				
total yearly old-age and WW&O-pension contribution	73.86	87.05	74.22	74.80
total yearly contribution	75.99	92.48	76.76	75.5
balance of benefits and contributions				
old-age and WW&O-pension benefit	696.58	352.36	225.38	229.01
total	320.23	227.34	167.80	194.91

The number of civil servants in the four subsequent generations is unequally distributed between men and women. In the first generation, the proportional number of female civil servants is about 62% that of men, which is equivalent to saying that about 62/162=38% of the civil servants are female. This proportional difference between men and women gradually becomes smaller over the generations, with the largest decrease between the second and third generation. For the last generation, the number of female civil servants is almost 88% of the number of male individuals. The development of the relative career length of female civil servants shows the same pattern, though the difference remains considerable. For the 1960 generation, the average length of the career of female civil servants is only 30% of that of their male colleagues. This large difference is probably caused by the large number of women who exited the labour market after getting married and becoming mothers (see figure 5.12 for the layoff probabilities of men and women). This difference between average careers decreases quite sharply, but even for the 1960 generation, the average length of the female career is still only 64 % of that of the male. When looking at the lifetime gross yearly wage of civil servants, the pattern changes, however. As opposed to the developments in the relative numbers of women and their average career length, the gross lifetime wage which women receive decreases in the last two generations. For the 1930 generation, the average wage-gap was about 7 % and for the 1940 generation, it turns out to be nonexistent. However, for the 1950 and 1960 generations, the gap is no less than 18 %. A possible explanation is that those 'extra' women who were hired in the younger generations, remained more than ever before in the lower career groups. Put differently, the increasing number of women in the force of civil servants did not result in an equivalent increase in the proportion of women in the higher hierarchical levels, with the result that the average wage-difference increased.

As wage is one of the most important variables in the determination of any pension benefit or contribution, it is straightforward that this important relative difference in wage between women and men affects the lifetime pension benefits and contributions. However, we have already considered the difference between the lifetime wages of men and women, so we would like to abstract the developments of the various pension benefits and contributions from this development of lifetime wages. This is the reason why the ratio of the specific lifetime benefits and contributions *relative to the lifetime wage* of females and males, respectively was taken as the point of departure. So, the numerator of the figures in table 6.7 is, for instance, the lifetime old-age pension benefit of women in a certain generation, relative to the lifetime wage of women in that generation. The denominator is of course the same figure, but then for men. A last remark which must be made is that, as in most other tables describing the base-variant, figures representing the disability and ERB schemes are excluded. As these schemes are financed through PAYG, they are less interesting in the light of our problem definition. It turns out that even abstracting from developments of the lifetime wages, interesting differences occur. First of all, let us consider the difference between the lifetime old-age pension benefit of women and men. As could be expected, the difference between the lifetime old-age pension benefits of women and men increases as well, clearly caused by the increasing difference in lifetime wages. However, the former increase is less than the latter, which is probably due to the fact that the difference between the average career length of women and men decreases (i.e. the percentage goes to 100). So, even though the difference in lifetime wages increases, the fact that the difference in average career length decreases causes the increase of the difference in lifetime old-age pension benefits to be less. The next pension benefit we consider is the WW&O-pension benefit, which clearly is an exception to the 'rule' that lifetime incomes and pension benefits of women are on average lower than men. For the 1930 generation, the lifetime WW&O-pension benefit is no less than 39 times higher than that of men. For the younger generations, this figure decreases greatly from a factor of about 12 and 15 for the 1940 and 1950 generations, respectively, to a factor of 6.6 for the 1960 generation. This factor is about 17% of that of the first generation, so men are catching up, though the difference still remains high. What causes this large positive difference between the lifetime WW&O-pension benefits for women and men? Firstly and to a lesser extent, one reason is that men simply were not eligible for a WW&O-pension benefit before 1987. Another explanation is the fact that, as shown extensively, the WW&O-pension benefit of an individual depends on the characteristics of the partner. In other words, if a civil servant deceases (from 1987 onwards, in the case of a woman), his or her marital partner receives a WW&O-pension benefit based on the characteristics of the deceased (such as the wage-base etc.). We just saw that there are less female than male civil servants. As a consequence, even if male and female civil servants were to have the same mortality rate, fewer (married) female than male civil servants actually decease, thereby leaving behind a WW&O-beneficiary. This in turn will have the result that the lifetime WW&O-pension benefit for men will be lower than that for women. This effect is strengthened by the fact that the mortality rate of women is not equal to that of men, but generally lower. So, even if there were to be exactly the same proportion of men and women, there still would be less male than female WW&O-pension beneficiaries. And the last reason why the lifetime WW&O-pension benefit for men is lower than that for women is equally straightforward, and has already been mentioned: the gross lifetime income of female civil servants is lower than that of male civil servants.

On the whole, the lifetime pension benefits for women are higher than those for men, a difference which is entirely caused by the WW&O-pension benefit. Apart from this pension benefit, women proportionally receive less from the pension fund than men. Next, let us consider the lifetime contributions to the pension fund. The most important contribution is the contribution concerning the old-age and WW&O-pension schemes. Again, contributions to the disability and ERB schemes are not included. For the reasons mentioned above, the lifetime contributions are proportionally lower for women than for men. However, even if we ignore the WW&O-pension benefit, this difference in contributions is higher than the difference in benefits. So, ignoring the lifetime WW&O-pension benefit for a moment, even though women proportionally get less lifetime income out of the pension fund, they still proportionally get more than they contribute, in relation to men. And if the lifetime WW&O-pension benefit is included, the last-but-one column of table 6.8. shows that the balance of lifetime incomes and contributions is almost a factor of 7 in favour of women for the first generation, about 3.5 and 2.5 for the second and third generations, respectively, and a factor of 2.3 for the last generation. So, despite that the average pension benefit (apart from the WW&O pension benefit) which women get out of the pension fund is considerably lower for women than for men. However, the average WW&O-pension benefit is much higher for women than for men, and women contribute less to the pension fund (even given the proportionally lower old-age pension benefit and other benefits (apart from WW&O)). So, proportionally speaking, women get more out of the pension fund than men do. Or, in other words, there is solidarity from male to female participants, a solidarity wich is mainly caused by the WW&O-pension benefit.

Before presenting and discussing the simulation results which distinguish the levels of education in the base-variant, we briefly consider the differences between males and females in the case of the transition from a final-wage scheme to an average wage-scheme in the year 2000. These results are presented in table 6.8 on the next page. The results in this table 6.8 should be compared to the results in table 6.7 which we have just discussed. A priori, we would think that the numbers would be closer to 100 for the last generation. Because the average career length is shorter for women than for men, and because men tend to have higher education than women (proportionally speaking), we would expect that the final-wage scheme causes the differences between male and female civil servants to increase in relation to the average-wage scheme. However, we are dealing with household income here, so these pension incomes are passed on to the marital partner, thereby to a large extent neutralizing differences between men and women. The differences which occur are the result of unmarried civil servants. We can therefore expect the effect of the transition from a final wage to an average wage to be small in the case of the old-age pension benefit, and larger in the case of the WW&O-pension benefit, since these recipients are unmarried. In the case of the WW&O-pension benefit, we would expect the inverse movement as in the case of the old-age pension benefit (remember that the WW&O-pension benefit is determined by the characteristics of the late partner).

Table 6.8: lifetime incomes of women, as a percentage of that of men, transition in 2000.

generation	1930	1940	1950	1960
number of individuals	62.24	64.77	79.58	89.55
career length	30.56	36.54	52.07	83.56
percentages of 1992-guilders				
gross yearly wage as civil servant	96.25	100.47	84.94	83.58
total yearly old-age pension benefit	125.72	99.14	80.96	85.47
total yearly WW&O pension benefit	5981.24	3620.11	1417.23	466.15
total yearly benefit	276.22	182.94	145.49	145.29
contributions				
total yearly old-age and WW&O-pension contribution	77.73	86.73	76.27	73.73
total yearly contribution	80.12	92.47	79.43	74.84
balance of benefits and contributions				
old-age and WW&O-pension benefit	1020.24	351.49	248.40	203.43
total	427.94	227.79	173.88	180.25

To summarize, we would expect the effect of such a change of the wage-base to have an equalizing effect, in the sense that the relative difference between the pension benefits of women and men would decrease. However, in the case of the lifetime old-age pension benefit, we would expect this effect to be considerably weaker than in the case of the WW&O-pension benefit. Note that this means that we would expect the figure for the old-age pension benefit (which is smaller than 100) to increase, whereas we would expect the figure for the WW&O-pension benefit to decrease: they would both move to the situation where the pension benefit is equal for men and women, which is 100%. Are these expectations confirmed by tables 6.8 and 6.7? When we consider the last column of tables 6.8 and 6.7, we see that the difference between the lifetime old-age pension benefit of women in relation to men has decreased from 89.74% in table 6.7 to 85.47%, which is the opposite of what we would have expected. This shift is however quite small. The change in the proportional difference of the WW&O-pension benefits between women and men is in line with expectations: as compared with table 6.7, this number decreases quite sharply from 586% to 466%.

NEDYMAS simulates seven levels of education, going from primary school to university (Nelissen, 1993, table 4.1, pages 92 and 93). As we are considering adult individuals, it is sufficient to group them in three categories or levels. In the next table 6.9, differences between levels of education will be highlighted.

Table 6.9: lifetime incomes of education-categories, as a percentage of the generation-wide value.

generation	1930			1940			1950			1960		
education category	1	2	3	1	2	3	1	2	3	1	2	3
number of individuals	39.02	38.20	22.79	35.72	37.88	26.40	34.91	35.63	29.46	34.19	41.83	23.97
career length	98.69	104.39	94.87	105.25	101.32	91.00	106.78	95.64	97.25	106.84	97.58	94.47
percentages of 1992-guilders												
gross yearly wage as civil servant	68.77	97.01	158.13	75.02	95.62	140.16	76.90	95.45	132.76	83.53	97.00	128.62
benefits												
total yearly old-age pension benefit	61.64	93.12	177.98	67.54	90.59	156.98	68.87	96.38	141.36	74.40	98.51	139.06
total yearly WW&O pension benefit	99.83	105.81	84.22	107.2	114.4	69.03	85.65	128.82	82.13	102.07	102.13	94.39
total yearly benefit	77.02	100.04	137.62	82.49	99.78	123.22	77.45	107.70	117.69	87.88	99.09	119.14
contributions												
total yearly old-age and WW&O-pension contribution	62.40	94.64	173.98	65.37	92.63	157.52	64.53	93.24	150.13	74.03	95.93	144.09
total yearly contribution	61.83	94.92	174.46	64.84	92.41	158.61	64.05	93.64	150.19	74.12	95.81	144.17
balance of benefits and contributions												
old-age and WW&O-pension benefit	87.40	101.10	115.71	89.27	102.48	110.25	78.28	113.15	109.92	89.57	101.12	113.49
total	82.14	101.76	125.22	87.80	101.99	112.58	81.18	111.62	108.65	91.89	100.04	111.84

The first category contains those who have at most a senior vocational training qualification ("middelbaar beroepsonderwijs"). The second level contains those individuals with a vocational colleges qualification ("hoger onderwijs") and the third level of course contains those who went to university ("wetenschappelijk onderwijs"). In the preceding sections, we dealt with two categories. So, all information was shown by expressing the 1992 guilder values of one category in relation to the other. In this case, however, we have three categories, so if we were to express the figures for one category in relation to the other, we would ignore the information for the third category. Instead, table 6.9 expresses the figures for the three educational categories as a fraction of the figure for the generation as a whole. This table shows three educational levels for each generation. The first row shows the relative number of individuals in each of the three educational levels. Note that the three percentages add up to 100. For the four generations, the percentages of individuals who have at most senior vocational training qualification and vocational college qualification are more or less the same and higher than the percentage of civil servants who have a university degree. However, this last percentage is still quite high, as table 6.9 shows. The changes between generations are not very great, nor do they show a clear pattern. The same goes for the relative generational-average length of the career, as shown in the second row. The only interesting thing which can be said about this variable, is that the average length of career of civil servants with a university degree is consistently shorter than that of the others. This difference is not very important, but it is the same for all generations with the exception of the 1950 generation. One possible explanation could be that the civil servants with the highest human capital value (of which education is one of the components) face a relatively high possibility of transiting to the private sector (Dekkers, 1994). But a more likely explanation is simply that higher-educated individuals enter the state of being a civil servant later in their lives, simply because they went to school for longer.

Next, let us consider the actual lifetime figures for the four generations and three educational levels per generation, where these figures are expressed as percentages of the generation-wide value. First of all, the third line of table 6.9 shows the gross yearly wage of civil servants. As could be expected, the higher the educational level, the higher the lifetime gross wage. This is especially the case between the second and third educational level (vocational colleges and university). However, when comparing the four generations, it can be seen that the lifetime incomes of the first and second categories (civil servants with senior vocational training and vocational colleges) increase from about 68% and 97% for the first generation to about 83% and 97% for the last generation. The proportional income of civil servants with a university degree gradually decreases from 158% to 129%. The differences between the old-age pension benefits of the three categories of civil servants, as well as their development over the four generations, clearly are determined by the development of the gross wages. It is, however, remarkable that the differences between the lifetime old-age pension benefit of the three educational categories are larger than those of the lifetime wage. So, compared to the average lifetime old-age pension benefit over all categories, the benefit of the first educational category is quite low whereas the benefit of the third educational category is quite high, both relative to the differences in lifetime civil servants' incomes. An explanation for this pattern lies in the exemption: the higher the income is -and we know from the above table 6.9 that the lifetime income of higher educated individuals is higher- the smaller the effect of the exemption becomes. This then causes the increasing patterns of lifetime wages to be magnified in their effect on -for instance- the lifetime old-age pension benefit. Note that the lifetime yearly old-age benefit for the three educational categories shows the same equalizing pattern over generations as the lifetime wage does, though the differences of the former remain larger than those of the latter. Apart from the second generation, this pattern where the differences between educational categories become smaller over generations also emerges in the case of the disability pension benefit.

For all the above-mentioned lifetime pension benefits, the general pattern is the same and caused by the development of the gross wage: the lifetime benefit increases with the educational level, but the development over generations is one where these differences become smaller. The exception to this is the lifetime WW&O-pension benefit. Its development is completely different, not only over education categories, but over generations as well. First of all, the lifetime WW&O-pension benefit is relatively the highest for the second educational category of civil servants, those who attained vocational colleges. Secondly, and this also holds true for the four generations, we find the category of civil servants with senior vocational training qualifications. As opposed to both the development of gross lifetime wages and the other pension benefits, the lifetime WW&O-pension benefit is the lowest for the category of civil servants with university degrees. The cause for this development remains unclear, unfortunately. If such a development were to occur in real life, it could be caused by differences in mortality rates between income classes. However, the mortality rates which are used in the demographic module of NEDYMAS are based on age, sex and marital status. One possible explanation, however, is the shorter average career length of civil servants with a university degrees. Another explanation could be that there is a more important gender effect. Remember that, before 1987, men were not eligible for a WW&O-pension benefit. It could be that the proportion of female civil servants is highest in the second education category. Earlier, I suggested that it could be that the average hierarchical position of women in the civil servant force decreased as the proportion of women increased. This would at least be somewhat in line with the fact that the average WW&O-pension benefit of the third educational level decreases in relation to that of the WW&O-pension benefit. This is of course distinct from the fact that, as table 6.2 shows for the first three generations, the average generation-wide WW&O-pension benefit decreases. This is confirmed by table 6.10, where thousands of individuals are distinguished according to gender and education. The figures in table 6.10. can be transformed to visualize the proportion of men and women in the three education categories. The figures in table 6.10 are expressed as a fraction of the total number of individuals of the same sex. Next, this figure for women is again expressed as a fraction of that for men. The result is given in table 6.10.2. The advantage of expressing the figures in the above way is that it corrects for differences between the figures for females and males. Table 6.7. showed that the former is considerably lower than the latter. Table 6.10.2. shows that in the first generation, women are more likely to be found in the highest educational category.

Table 6.10: thousands of individuals, according to gender and educational level.

		men			women		
generation	education level	1	2	3	1	2	3
1930	mean	56.40	55.10	31.50	34.00	33.40	21.30
	st.err	2.27	2.10	1.43	2.83	1.83	1.72
1940	mean	95.30	91.80	68.30	54.60	67.20	42.50
	st.err	3.49	2.28	2.28	1.87	2.28	1.98
1950	mean	133.90	108.20	119.50	96.80	127.30	75.20
	st.err	4.19	3.47	2.60	3.71	2.02	2.85
1960	mean	144.90	134.20	113.80	107.40	174.50	84.93
	st.err	4.75	6.08	3.05	3.35	4.95	2.79

However, for the other generations, we see that there is a shift in the increasing proportional number of women (table 6.7) from the third to the second educational category (senior vocational college).

Note, by the way, that this also supports our earlier line of reasoning explaining why the lifetime civil servant's wage of women decreased in relation to that of males (table 6.7)

Table 6.10.2: proportion of women in education categories, as a fraction of that of men.

gener./educ	1	2	3
1930	0.97	0.98	1.09
1940	0.89	1.14	0.97
1950	0.87	1.42	0.76
1960	0.79	1.39	0.80

Turning back to table 6.9, it appears that the relative lifetime wage of civil servants in the various educational categories is the main determinant for the relative level of the lifetime pension benefit as well as their converging development over generations. When looking at how the lifetime contributions to the pension fund are distributed over the educational categories, the same pattern as before emerges. However, this time it is more extreme and there is no equalizing shift over generations. So, when balancing benefits with contributions, we would expect to see a less important positive difference in the lifetime net-benefits between higher and lower educational categories, if any. This is confirmed by looking at the relative balance of benefits and contributions over educational categories and generations. Note, first of all, the large impact of the WW&O-pension benefit. As a result of this, the pattern where the net lifetime benefit is the highest for the highest educational category only holds for the first generation. After that, again as a result of the WW&O-pension benefit, the relative lifetime net benefit of the second educational category, (vocational colleges), increases relative to that of the third category (university) and even becomes the highest for the 1950 generation. This catching-up of the lifetime benefit, however, does not occur for the first educational category (senior vocational training). But apart from this, the above-mentioned pattern remains clear: higher-educated individuals (especially those with an university degree) get more out of the pension fund than lower-educated individuals (especially those with senior vocational college qualifications). The conclusion, therefore, is that the pension fund redistributes lifetime income from those civil servants who attained university to those who followed vocational colleges. This conclusion holds at least for the last two generations.

We have now discussed the lifetime results for the entire generation, which allowed us to draw conclusions on intergenerational redistribution. Next, redistribution of lifetime contributions and benefits between men and women and, thirdly, three educational categories, were considered. The next step then is to consider the combination, i.e. redistribution between men and women in the various educational categories. One of the conclusions which were drawn from table 6.9 was that the WW&O-pension benefit caused important redistribution of lifetime-income from men to women. Table 6.9 then showed that the WW&O-pension benefit had an important effect on the redistribution between educational categories as well, in the sense that it causes the redistribution of lifetime income from civil servants with a university degree to those who attained vocational colleges. The relative figures for women as a percentage of those for men in the same category are shown in table 6.11. Before discussing this table, it should be remembered that the more the sample is subdivided into smaller groups, the more vulnerable the simulation results become to Monte Carlo variance. It is therefore interesting to consider the absolute t-values of the hypothesis that both figures underlying the above ratio differ significantly from each other. These values are presented in table 6.13. For a good understanding of table 6.12, note that its values are not directly derived from table 6.11, though they have the same basis. In earlier tables (such as table 6.6 and the tables before that), figures on lifetime benefits and contributions were first expressed in relation to the lifetime civil servants wage. In tables 6.7 to 6.12, however, this is not the case, in order to maintain the link between all these tables. Since the figures in the table 6.11 are derived by taking the ratio of the figures for women and men in the same education category and the same generation, these figures do not come with the standard errors needed to calculate t-values. Thus, the figures in table 6.12 come from the original simulation results. For instance, for the 1930 generation and expressing all numbers in thousands, the numbers of women and men in the first education category are 34 and 56.4. The standard errors which come with these numbers are 2.83 and 2.27. The t-value for the difference between the number of female and male civil servants in the first education category therefore becomes (34-56.4)/(2.83+2.27) which is -4.39. A consequence of this is that neither the figures in table 6.11 nor those in table 6.12 correct for the difference in lifetime civil servants' wage. The interpretation and discussion of table 6.11 will therefore take the t-values in table 6.12 into account.

Table 6.11: lifetime incomes of education-categories, women as a percentage of men

generation	1930			1940			1950			1960		
education category	1	2	3	1	2	3	1	2	3	1	2	3
number of individuals	18.81	17.56	20.71	17.31	24.98	26.47	33.88	62.94	39.65	42.12	87.47	73.94
career length	31.34	28.76	30.37	31.22	33.64	42.86	46.52	53.18	63.40	56.88	67.81	99.22
gross yearly wage as civil servant	93.81	98.72	81.48	108.84	108.23	85.69	94.84	83.68	76.66	93.31	80.71	71.28
benefits												
total yearly old-age pension benefit	130.59	129.85	68.00	127.08	117.97	79.60	102.31	83.45	71.46	112.41	87.36	60.82
total yearly WW&O pension benefit	5032.62	6007.29	1611.22	2574.67	2130.27	1457.96	682.34	1989.28	1042.38	683.03	823.05	309.02
total yearly benefit	343.70	278.55	103.80	280.06	204.52	111.03	170.37	151.49	112.96	212.54	153.62	92.16
contributions												
total yearly old-age and WW&O-pension contribution	78.50	80.54	60.72	93.95	95.58	75.31	87.20	76.97	70.50	89.44	72.95	31.00
total yearly contribution	81.01	83.45	62.19	101.03	102.14	79.28	91.49	79.50	72.47	91.03	73.54	38.1
balance of benefits and contributions												
old-age and WW&O-pension benefit	1365.14	1028.90	251.86	555.47	437.09	179.92	257.99	268.75	169.37	317.59	233.86	139.06
total	528.26	431.91	129.60	358.29	249.42	127.08	195.73	178.28	132.45	263.10	193.92	119.44

Table 6.12: t-values for the difference between men and women in three educational categories.

generation	1930			1940		
education category	1	2	3	1	2	3
number of individuals	-4.39	-5.51	-3.23	-7.6	-5.4	-6.06
career length	-16.87	-16.01	-11.40	-17.61	-22.95	-15.99
gross yearly wage as civil servant	-1.16	-0.23	-3.35	1.86	1.77	-3.14
total yearly old-age pension benefit	1.34	1.55	-2.57	1.81	1.90	-1.44
total yearly WW&O pension benefit	2.98	2.04	3.75	2.77	5.24	3.54
total yearly benefit	2.85	2.13	0.21	3.10	3.58	0.53
total yearly old-age and WW&O-pension contribution	-2.88	-2.71	-6.69	-0.95	-0.74	-3.72
total yearly contribution	-2.44	-2.11	-6.54	0.14	0.34	-2.81
generation	1950			1960		
education category	1	2	3	1	2	3
number of individuals	-4.69	3.47	-8.13	-4.63	3.65	-3.96
career length	-20.02	-12.90	-8.37	-13.70	-8.92	-0.17
gross yearly wage as civil servant	-1.63	-5.71	-7.92	-3.07	-8.09	-9.60
total yearly old-age pension benefit	0.28	-2.29	-4.60	1.55	-1.72	-7.27
total yearly WW&O pension benefit	4.30	6.74	4.44	4.05	5.34	2.81
total yearly benefit	3.74	2.63	0.75	3.51	3.63	-0.63
total yearly old-age and WW&O-pension contribution	-1.58	-3.07	-4.46	-1.13	-3.65	-10.42
total yearly disability and ERB- contribution	0.83	-1.32	-3.10	-0.65	-3.82	-7.12
total yearly contribution	-1.06	-2.87	-4.49	-1.14	-4.18	-10.42

When considering the number of female civil servants as a percentage of male civil servants, the idea that the increasing proportion of women was accompanied by a decreasing average hierarchical position of female civil servants, is again, although indirectly, confirmed by table 6.9. This table shows that, between the 1930 and 1940 generations and the 1940 and 1950 generations, the proportion of women in the highest educational category increases considerably less than in the other categories, especially the second educational category. This confirms what was already suspected: the 'extra' women who are recruited, and who cause the proportion of female civil servants to increase, more often than before have vocational colleges qualifications. It is only between the 1950 and 1960 generations that the proportion of women with university degrees increases considerably more than in the other categories. The second (data-)row of table 6.9 as well as the second and tenth rows of table 6.10 show that the lifetime average career length is shorter for women than for men. This is not very surprising, given what we saw in table 6.6. However, this difference is lower for the higher educational categories, for the 1950 generation and especially for the 1960 generation. The third data line of table 6.11 and the third and fourteenth data lines in table 6.10 show that the difference between the lifetime civil servants' wage of women and men is larger for the higher educational categories. Firstly and most importantly, even taking into account that there are fewer women than men civil servants, those women who are civil servants, are more often found in the second (and first) educational category (see tables 6.10 and 6.10.2). So, women are proportionally under-represented in the highest educational category. Moreover, women more often have part-time jobs and a higher layoff rate (which also explains the large difference in average length of career), for which the data have not been corrected for. We can expect that this pattern will have a strong effect on the relative figures in the other rows of this table. This is certainly the case for the old-age pension benefit. The average lifetime old-age pension benefit for women in the first educational category varies between 130 and 102% of that of men. However, the test statistic for this difference is at most 1.55 (for the 1960 generation), so we can safely conclude that the hypothesis of a positive difference can be rejected[46]. Next, we turn to the WW&O-pension benefit. For the interpretation of these figures it is important to realize that the classification of women in educational categories is based on their own educational level, not on that of their husbands. Based on tables 6.7 and 6.9, we concluded that there was partial redistribution of WW&O-pension benefit from men to women and from civil servants with a university degree (the third educational category) to those who attained vocational colleges (the second category). But how about the combination of the two? Table 6.11 and 6.12 shows that the lifetime WW&O-pension benefit of women is considerably higher than that of men, irrespective of what educational category we consider. This difference is the greatest for the second educational category (vocational colleges) and decreases over generations, as was argued when discussing table 6.11. An explanation for these two observations could again be based on the fact that the WW&O- benefit which an individual gets, depends on the characteristics of the late partner. First of all, in the demographic module, the educational level of the women is usually of the same level or lower than that of their husbands (or, at least, this is more probable than the opposite), which means that those male civil servants who earn the most (and whose partners will get the highest WW&O-pension benefits in the unfortunate event that their husbands die) have university degrees (the third education category). The women who were married to these men will most likely be found in the second (and third)

[46] Given a one-sided test and assuming $\alpha=0.05$, the t-value is at least 1.645 for df=∞, and is 1.761 for df=min(n1,n2)-1=14 (Madsen&Moeschberger, 1986, equation 7.26, p. 327).

educational category. Moreover, the fact that the proportional difference between men and women in the civil servant force is decreasing explains why the proportional difference between the WW&O-pension benefit of women and men is decreasing over the generations.

When considering the distribution of lifetime contributions to gender and educational categories, the lifetime old-age and WW&O-pension contributions are what could be expected. Women contribute less to the pension scheme than men, a difference which is explained by the difference in length of career and by the difference in income. The development of the relative difference of the total net benefit between men and women is largely determined by the important relative profit which lower-educated women get from the WW&O-pension benefit. This conclusion clearly holds for all but the 1960 generation. Women in the first educational category of the 1930 generation receive no less than 5.3 times the net lifetime income than that of men. For the second generation, this factor is lower, but still quite important: about 3.6. Next, for the third generation (1950) this factor decreases sharply to 1.9. For the last generation (1960), women no longer receive more lifetime net pension benefits than men, a development which is caused by the fact that the partners of female civil servants became eligible for such a benefit from 1987 onwards. Moreover, due to the fact that the difference between lifetime wages of male and female civil servants becomes smaller, the redistribution of income is less between men and women in the middle and highest educational categories, though the differences remain important. The conclusion that this redistribution of income between men and women was decreasing over generations was already drawn when discussing table 6.7. It is therefore not surprising that this can be seen in table 6.11 as well.

This chapter started with a discussion of the simulation results of the pension fund itself, categories of individuals, assets, actuarial pension claims, and so forth. We then turned to the main part of this chapter, namely the lifetime income-results. Here, average-lifetime incomes, contributions and benefits were considered in more detail. In the remainder of this chapter, the distribution of these lifetime incomes, contributions and benefits will be presented and discussed. This allows us to draw conclusions about the effect of the pension fund ABP on the distribution of lifetime income.

Of course, the primary goal of this study is the analysis of the intergenerational redistribution of income. The distribution of lifetime income within groups or generations is in this respect of lesser importance, so this will be dealt with less extensively. Do the net benefits paid out by the ABP reduce or increase the inequality of lifetime income? This question will be dealt with using three measures of dispersion, the Theil-coefficient, the Gini-coefficient and the decile-ratio. The reason for using three of these measures is that they all highlight various aspects of the distribution of lifetime income or one of its derivatives such as contributions, benefits and so forth. The Theil-coefficient is written as $1/N \times \Sigma(y_i /mean(y) \times log(y_i / mean(y)))$ where y_i is the household income of individual i, and it ranges between zero and the log of the sample-size N. The Theil-coefficient is especially sensitive to changes at the lower half of the income distribution. The Gini-coefficient is usually written as $(2/N^2 \times mean(y)) \times \Sigma(i - (N+1)/2)$ for incomes arranged in ascending order. The Gini ranges between zero and one. It is equally sensitive to changes in each part of the distribution[47]. The last measure of dispersion used is the decile ratio. It is the ratio of the 10^{th} decile and the first decile. In other words it is the income of the 10% households with the highest income, relative to the income of the 10% households of the lowest income. It therefore represents the distance between the tails of the income distribution. This third paragraph will roughly have the same form as the first two paragraphs. This paragraph will start with presenting and discussing the three measures of dispersion for the well-known variables, such as yearly lifetime income, various benefits, contributions and so forth. Next, the information for men and women will be distinguished. The simulated inequality of lifetime income will not be specified to education, nor will the effect of the transition from a final wage scheme to an average wage scheme to the distribution of lifetime income be discussed.

Analogous to the tables of lifetime-income, table 6.13 shows the measures of dispersion of the lifetime income of civil servants and this income plus various benefits and minus contributions. Table 6.13 does not include Monte Carlo variance. So, table 6.14 shows the t-values of the measures of dispersion of the above table 6.12. The t-values in table 6.14 show whether or not the specific pension benefit or contribution changes the inequality of income, relative to the inequality of the lifetime civil servants' income. So, the t-value showing the statistical significance of the lifetime old-age pension benefit is 0.256-0.228 (see table 6.13)

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[47] See, for instance, OECD, 1997, Annex 2, pp.10 and further. Of course, in the current setup, it would have been better methodologically to use the Shorrocks-decomposition rule (idem, pp.14 and further and Shorrocks, A., 1982). This rule is independent of the inequality-index used or the order by which the income components are included. However, it is much more difficult to interpret than the results of the method used here. Moreover, in this case, there is a straightforward order in which the income components are included, in the sense that it is clear that the lifetime wages form the point of departure for both contributions and various benefits. For these reasons, it was decided not to use the Shorrocks-decomposition rule and to stick to the above method.

divided by the sum of their standard errors, (which is 0.009+0.01) resulting in 1.42 (see table 6.14).

Table 6.13: The effect of lifetime benefits and contributions on the dispersion of income.

generation	1930			1940		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	0.228	0.368	4.829	0.160	0.310	3.207
wages plus old-age pension benefits	0.256	0.389	5.509	0.186	0.332	3.495
wages plus WW&O pension benefits	0.381	0.425	5.003	0.297	0.371	3.274
wages plus total pension benefits	0.389	0.444	5.932	0.315	0.394	3.416
wages minus old-age and WW&O-contributions	0.222	0.361	4.621	0.152	0.302	3.267
wages minus all contributions	0.220	0.360	4.594	0.148	0.297	3.841
wages plus all benefits minus all contributions	0.406	0.448	5.826	0.329	0.396	3.068

generation	1950			1960		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	0.148	0.299	3.022	0.125	0.274	2.735
wages plus old-age pension benefits	0.171	0.318	3.243	0.136	0.287	2.913
wages plus WW&O pension benefits	0.266	0.357	3.211	0.267	0.345	2.936
wages plus total pension benefits	0.284	0.377	3.599	0.255	0.353	3.213
wages minus old-age and WW&O-contributions	0.139	0.289	2.898	0.115	0.263	2.613
wages minus all contributions	0.133	0.283	2.825	0.110	0.258	2.550
wages plus all benefits minus all contributions	0.293	0.378	3.504	0.267	0.355	3.133

Only the last line of table 6.14 is an exception to this, since it gives the statistical significance of all lifetime contributions, relative to the inequality of income *plus all lifetime benefits*. The reason for this will become clear later. Finally, we turn to the actual discussion of the inequalities. First of all, note that the inequality of the civil servant's lifetime wage is quite high in the first generation, and decreases strongly afterwards. For the first (i.e. 1930) generation, the Gini is .368. It then decreases strongly to .310 for the 1940 and .299 for the 1950 generation. The Gini for the 1960 generation is then .274. For the Theil-coefficient, the pattern is much alike: it starts at no less than .228 for the first generation and then decreases via .160 for the second generation to .148 and .125 for the last two generations. This observation of decreasing income inequality is not very unexpected; the magnitude is, however. It is inevitable that this peculiar pattern is related to the fact that individual incomes instead of household incomes are calculated in this study.

Table 6.14: t-values of the measures of dispersion in table 6.13

generation	1930			1940		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant						
wages plus old-age pension benefits	1.42	1.50	1.19	2.60	2.85	2.91
wages plus WW&O pension benefits	2.18	2.17	0.33	4.65	5.05	2.74
wages plus total pension benefits	2.79	3.17	1.76	6.19	7.25	5.32
wages minus old-age and WW&O-contributions	-0.35	-0.45	-0.41	-1.00	-1.15	-1.87
wages minus all contributions	-0.41	-0.52	-0.47	-1.62	-1.79	-2.69
wages plus all benefits minus all contributions	2.85	3.23	1.55	6.26	7.18	4.56
wages plus all benefits minus all contributions(2)	0.17	0.13	-0.14	0.30	0.14	-0.61

	1950			1960		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant						
wages plus old-age pension benefits	2.66	3.38	3.37	2.44	2.80	3.05
wages plus WW&O pension benefits	6.75	6.86	2.21	8.11	9.38	2.77
wages plus total pension benefits	6.74	8.78	7.78	7.31	10.61	6.91
wages minus old-age and WW&O-contributions	-1.40	-1.69	-1.88	-1.80	-1.94	-2.05
wages minus all contributions	-2.38	-2.82	-3.05	-2.76	-2.97	-3.16
wages plus all benefits minus all contributions	6.73	8.56	6.52	7.07	10.20	5.54
wages plus all benefits minus all contributions(2)	0.28	0.07	-1.19	0.36	0.17	-0.98

But what we are interested in is the effect of the various benefits and contributions on this dispersion of lifetime civil servant's wage. The most striking is that all lifetime pension benefits cause the income inequality to increase. This is not unexpected: most of these benefits are based on the income minus an exemption. The higher the income, the lower the proportional size of the exemption, and therefore the higher the proportional pension benefit. Moreover, over time, the exemption changes with the general wage index. The change in wages is, however, higher, since it also depends on the incidental wage growth of 1% per year. So, the exemption lags behind the average wage level over time. Consequently, we can expect that this inequality-increasing effect becomes stronger over generations. At first, this does not seem to be confirmed by the data in table 6.13: for the 1930 generation and when the lifetime old-age pension benefit is included, the Gini increases by 5%. For the 1940 generation, this increase is only 3%. For the 1950 and 1960 generation, the increase is 4% and 6% respectively. However, when considering the t-values of table 6.14, and again comparing the inequality of lifetime wages with the inequality of lifetime wages plus old-age pension benefits, confirmation for this development of the inequality-increasing effect is found for the old-age pension benefit.

The inequality-increasing effect on lifetime income is not very strong for the 1930 generation (the t-value of the Gini is only 1.5, meaning that the hypothesis of no equalizing effect cannot be rejected), but becomes considerably stronger for the other generations (2.85 and 2.80 for the 1940 and 1960 generations), with the greatest effect for the 1950 generation (a t-value of 3.38). In this last case, for the Theil-coefficient and the decile ratio, the same pattern emerges. For the inequality-increasing effect of the WW&O- pension benefit, the same pattern emerges much more explicitly than in the case of the old-age pension scheme. The t-values of the Gini-coefficient start at 2.17 for the 1930 generation, then become 5.05 and 6.86 for the 1940 and 1950 generations, and end up at no less than 9.38. The same arguments as in the case of the old-age pension benefit cause this pattern.

Next, we consider the effect of the pension contributions on the inequality of lifetime income. As the pension benefit and the pension contribution are essentially based on a certain income minus an exemption, it may come as no surprise that the effect of lifetime contributions is opposite to that of the various benefits: they cause the lifetime income to become more equal. Again, for the reasons mentioned earlier, this effect increases over the generations. For the 1930 generation, the Gini decreases by 2% from .368 to .361 (for the old-age and WW&O-contributions) and .360 (for the total contributions). However, table 6.14 shows a t-value of -.45 which is statistically insignificant (see footnote 46). For the other generations, as already said, this effect is stronger. For the 1940 and 1950 generations and considering only the old-age and WW&O-contributions, the Gini decreases by just 3%. However, the t-value decreases from -.45 to 1.15 and -.69 respectively. For the 1960 generation, this value is -1,94. For this generation, the Gini decreases by 4% from 0.274 to 0.263. On the whole, as compared to the effect of lifetime benefits, the effect of the lifetime contributions is considerably less. The last row of table 6.14 shows the compound effect of lifetime pension benefits and contributions, i.e. the effect of all lifetime pension benefits and contributions on the inequality of lifetime income. At first sight, this causes concern, because it could be concluded from the comparison of the inequality measures in this row with those of the lifetime wage plus benefits that contributions *increase* inequality (compare .406 with .389, for instance) which is in contradiction to the separate effect of the various contributions. However, the last row of table 6.14 shows that the t-value of the difference between the inequality of the lifetime income plus contributions, on the one hand, and the inequality of the lifetime income plus contributions minus benefits, on the other hand, never exceeds .36, which leads to the conclusion that this confusing comparison in the last line of table 6.14 is based on inequality figures which are statistically not significantly different from each other.

Chapter 7: simulation variants.

Introduction

Chapter 6 presented the simulation results of the model as described in the previous chapters. It was shown that the inclusion of a module representing the ABP in the microsimulation model caused the lifetime income of all generations to increase quite considerably. However, when correcting for the average profit, it was shown that there is implicit intergenerational redistribution from the first two generations to the last two generations. Shifting from a final wage scheme to an average wage scheme in 2000 causes an implicit intergenerational income stream from the youngest generation to the other generations.

In this chapter, the effect of some changes in the structure of the pension fund on these implicit intergenerational income flows will be considered. These changes run from another course of the exogenous rate of return to a complete abolition of the pre-privatized pension scheme. However, before turning to the actual discussion of these simulation variants, we should dwell a moment on how the effects of these variants should be presented. Earlier, intergenerational redistribution of income was represented by the deviations from the average profit which each generation gets from the pension fund. This way, a zero-sum-game was implemented. However, does this technique allow for comparison between variants? Or, at least, does it make sense? Not really, for a couple of reasons. The first reason is that the method described above is entirely based on differences. Initially, the difference between benefits and contributions is taken. Next, for each generation, the difference between the net-benefit and the average net benefit over generations is derived. Consequently, if all benefits and all contributions for all generations are multiplied by 2, the generational profits or losses will be multiplied by two as well, thereby frustrating any comparison, even though nothing has really changed. Moreover, the above technique basically shows which generation gets what part of the profit gathered by the pension fund. But what if the total profit changes as a result of a certain policy measure? Then comparison of the effect of a certain policy measure on the profit which a certain generation gets from the fund becomes blurred by the effect of this measure on the average profit, namely via its effect on the profit of other generations. Would it not be better to evaluate the effect of a certain policy measure in terms of its effect on the benefits and contributions of a single generation? The most appropriate way to do this is by comparing the ratio of the benefits and contributions for every generation. This way, it is interesting and more informative to consider how a certain policy measure changes the relative profit of each generation individually, in other words without considering the effect on the other generations. So, for the simulation variants which are to be discussed now, the lifetime incomes will be expressed as a ratio with the same value in the base-variant. The figure showing the intergenerational redistribution of income, as compared with the base-variant, will be provided, but the reader should take its limited informative value into account. Having said all this, let us turn to the actual discussion of the simulation variants. These variants will be numbered, starting from 2 (the first variant is the base-variant which was discussed in the last chapter). However, one last remark needs to be made. As these variants do affect entire cohorts of participants, without distinguishing between gender, educational level or the combination of the two, the following tables will apply to entire generations as well.

Before turning to the actual discussion of the simulation variants, it should be noted that these simulation variants are based on different, randomly selected starting values. What this exactly implies, what the consequences are and why this has been done, is explained in appendix 4.

7.1. variant 2: A changing rate of return.

Perhaps the most crucial variable in the pension fund module is the exogenous (nominal) rate of return on investment. Its cruciality is why it was kept exogenous. This might seem a paradox, but the choice came down to either model it thoroughly, which would have been a research project on its own, or keeping it as simple as possible, i.e. exogenous. The reader is referred to section c of paragraph 5.4 for a more elaborate discussion. Moreover, the fact that it is exogenous allows us to change the course of this variable, considering the results of this change on the lifetime-income results of the four generations under consideration. Figure 7.1 shows the original and adjusted exogenous rates of return. In the above simulation results, the

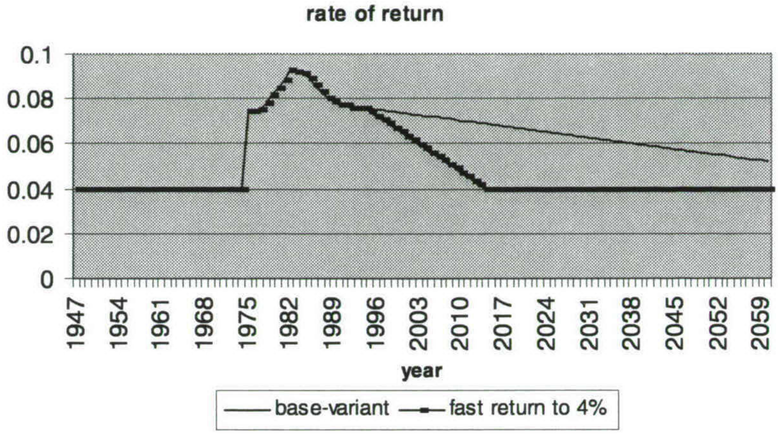


Figure 7.1

rate of return was set equal to its historical value, insofar that this information was available. After that, the rate of return decreases very slowly to 4%. However, it never reaches this in the simulation period. However, over the last years, the world has experienced decreases of the long-term rate of interest. Moreover, there are some reasons to expect lower real rates of return in the future as well. First of all, demographic ageing will cause the productivity of capital to decrease. The line of reasoning is basically that, as a result of ageing, the ratio of labour to capital is expected to decrease. This implies an increase of the productivity of labour relative to capital, which means that wages will increase faster than the rate of return on investments. Moreover, at a more practical level, all pension funds together hold more than 1,000 billion guilders of savings (WRR, 1999, p. 169). In one or two decades from now, the entire baby-boom generation will retire in a period of about fifteen years. This means that all these pension funds will start dissaving, and all roughly at the same time. So, the supply of capital will increase sharply. One could argue that this extra supply would be exported, following the notion that the real rate of return is exogenous in a small open economy such as the Dutch one. However, the Netherlands is not the only country whose population is ageing. The same development is occurring in most Western countries. Moreover, there may be doubts as to the international mobility of capital (Gordon, Bovenberg, 1996). This will unavoidably cause the long-term interest rate to decrease (Brooks, 2000, Oosenbrug, 1999).

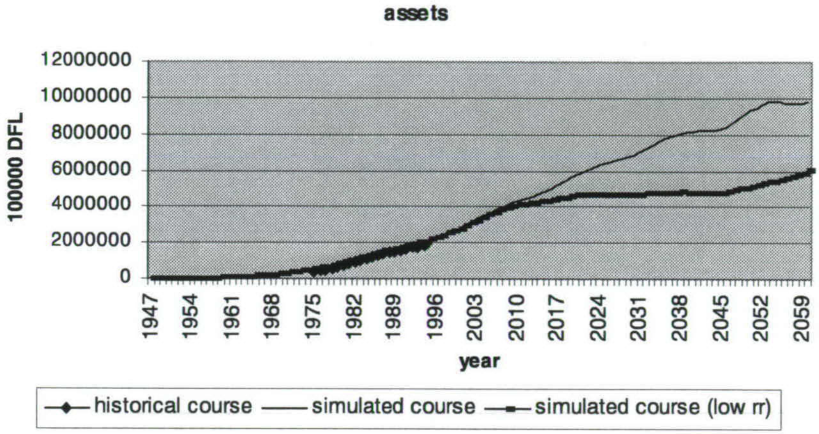


Figure 7.2

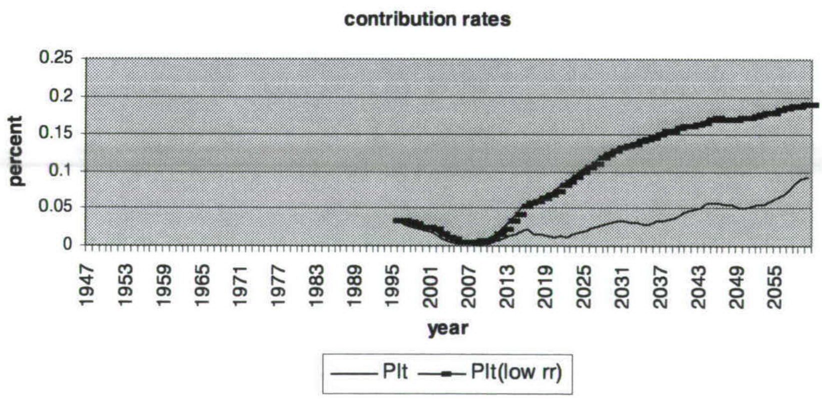


Figure 7.3

Of course, a decrease in the long-term interest rate could be accompanied by increases of the return on stocks and bonds, but as the largest part of assets is still invested in loans and not in stocks and bonds (Oosenbrug, 1999), we can expect that the latter effect will not outperform the former. It is therefore of importance to consider what the effect of such a decrease will be. In the simulation results which will be discussed now, the speed of decrease is increased five times, relative to the base-variant. As a result, the rate of return reaches the floor of 4% before 2020.This is shown in figure 7.1. What would be the result of this lower exogenous rate of return? Basically, pension benefits are financed either by contributions or returns on investments. So, if the latter decreases, the former necessarily must increase. Moreover, as the participants of the pension fund become older, their total sum of savings increase. The result of this is that changes in the rate of returns on investment will have a stronger effect on the contribution rate which is needed to cover these changes. As neither the actuarial discounted future pension claim and the contribution-base change, this higher contribution rate must be caused by lower assets. Or, to put it more in line with causality, as a result of the lower rate of return, assets decrease relative to their development in the base-variant, with the result that contribution rates go up. This is confirmed by the simulation results. Figure 7.2 shows that the assets decrease quite considerably, and the resulting increase in the endogenous contribution rate is shown in figure 7.3. It is interesting to see that the effect of the lower rate of return, which starts from 1995 onward, becomes visible only about fifteen years later. This is the direct result of the vintage-character of the assets-module. As a result of this, the self-enforcing effect of the lower rate of return, via lower assets to lower returns in guilder-value, only starts after about fifteen years. Note that the real rate of interest in this variant converges to its development in the base variant, so that assets and contributions will (in the very long run) return to their base-variant-levels.

What is then the effect of this lower real rate of return on the lifetime incomes of the participants in the pension fund? This is shown in table 7.1 on the next page. It should be noted firstly that both the relative pension benefits as well as the contributions as a percentage of the lifetime civil servant's wage end up quite close to the base variant. Moreover, there does not seem to be a persistent positive or negative difference between the results in the base-variant and this variant. For instance, when comparing the lifetime-old age pension benefit as a percentage of the lifetime wage, in the first line in table 7.2.1-we see that the difference is 7.6% for the 1930 generation, about 1% for the 1940 generation, then -2.5% for the 1950 generation and finally .95 for the 1960 generation.

Table 7.1: lifetime simulation results.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	20.56003	23.24455	24.68549	24.61801
total yearly WW&O pension benefit	14.42924	15.7452	16.35485	16.25785
total yearly benefit (ex. Ret.pay)	46.22291	50.145	50.24636	49.43607
total yearly old-age and WW&O-pension contribution	11.37674	9.779576	8.84098	9.627025
total yearly contribution	11.63924	11.26568	11.26793	12.71802
total benefit minus total contribution	34.58367	38.87932	38.97843	36.71805

This shows that the effect of simulation errors on the simulation results of the old-age and WW&O pension benefit is very small or even nonexistent. In the previous chapter, it was argued that the simulation results of the disability pension benefit and ERB would be more vulnerable to simulation errors, as the numbers of individuals which are involved in these pension schemes are less than in the case of the old-age and WW&O-pension schemes. The fact that the simulation results of these last schemes differ is therefore not surprising. Fortunately, the amounts involved in these schemes are so small that the conclusions will not be affected.

Table 7.2.1: lifetime simulation results: difference with base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	1.076	1.010	0.976	1.009
total yearly WW&O pension benefit	0.855	1.060	1.026	0.858
total yearly benefit (ex. Ret.pay)	1.002	1.029	0.977	0.964
total yearly old-age and WW&O-pension contribution	1.007	0.998	1.009	1.126
total yearly contribution	1.002	1.001	1.007	1.098
total benefit minus total contribution	1.002	1.037	0.969	0.925

Of course, Table 7.2.1. does not include the effect of the Monte Carlo variance on these simulation results. To overcome this, table 7.2.2 on the next page shows the t-values of some key benefits and contributions.

What conclusions can then be based on the last two tables? The first main conclusion which can be based on table 7.2.1. is that the contributions in general do not change considerably in relation to the base variant. This is in line with what we would have expected. The only thing is that, as compared with the simulation results of the base-variant, the yearly lifetime WW&O-pension benefit seems to end up about 14% lower for the 1930 and 1960 generations.

Table 7.2.2: t-value of the difference with the base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	1.11	0.11	-1.08	0.11
total yearly WW&O pension benefit	-0.40	0.25	0.08	-1.23
total yearly benefit (ex. Ret.pay)	0.15	0.34	-0.74	-0.76
total yearly old-age and WW&O-contribution	0.62	-0.15	-0.09	1.62
total yearly contribution	0.48	-0.08	-0.14	1.51

However, table 7.2.2. shows that these changes can mainly be attributed to Monte Carlo variance in the simulation results. The second main result is that the (old-age and WW&O) contributions end up almost 13% higher for the 1960 generation. Table 7.2.2. shows that this change is unlikely to be caused by Monte Carlo variance.

When considering the effect of a transition from a final wage scheme to an average wage scheme in the year 2000, we did not only consider the effect on the intergenerational redistribution of income (by comparing the deviations of the lifetime profit from the average lifetime profit, as shown in figure 8.16 and 8.17), but we also considered the profit of the three generations itself, so without subtracting the average profit of these generations. We will do the same thing here, but this time in reverse order. Figure 7.4 shows the profit which the subsequent generations get from their participation in the pension fund.

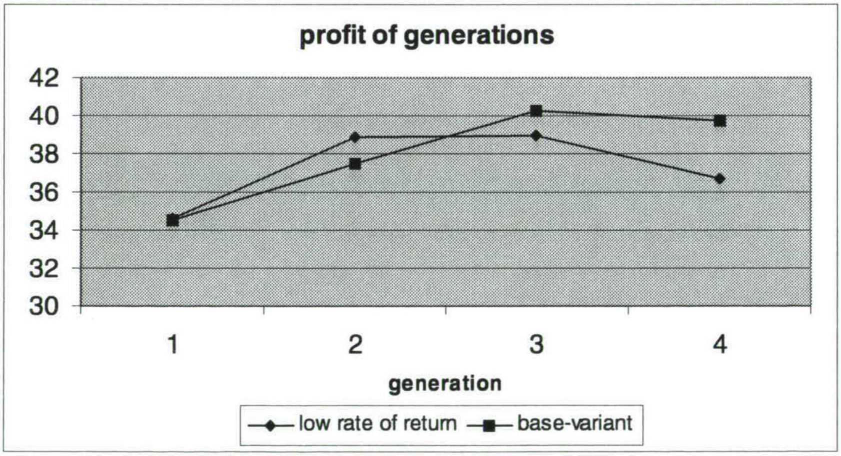
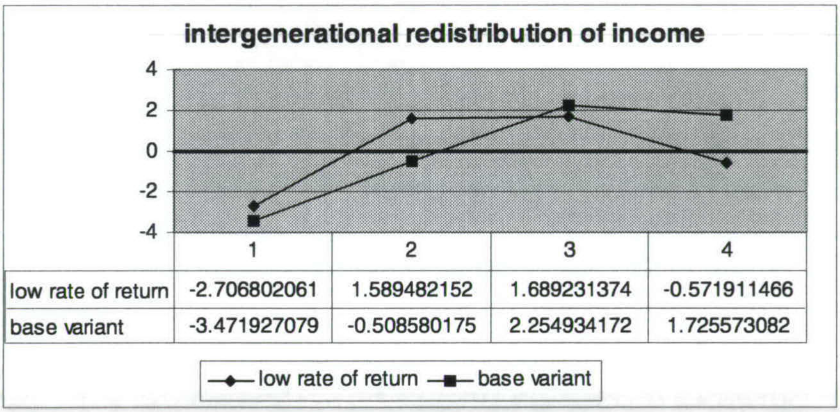


Figure 7.4: The effect of a lower real rate of return on investment after 1995 on the profit of generations.

At first, the difference given the lower rate of return (variant 2) to the base-variant, causes some confusion. The fact that the profit of the 1930 generation is the same in both variants, and that the profit of the 1960 generation decreases by no less than 7.2% in relation to the base variant, is entirely in line with expectations. But what causes the apparent increase in the profit of the 1940 generation by about 3.7%? And likewise, what explains the decrease in the profit of the 1950 generation by about 3%? Table 7.2.2. gives the answer: the increase in the profit of the 1940 generation as well as the decrease in the profit of the 1950 generation is caused by small and insignificant changes in the lifetime old-age pension benefit of this generation. These changes are insignificant, but as the number of beneficiaries is high, these changes do affect the average profit.

Next, and by analogy with figure 8.16, the following figure 7.5 shows how the pattern of intergenerational redistribution of income changes as a result of the lower rate of return which the pension fund gets from investing its assets.



	1	2	3	4
low rate of return	-2.706802061	1.589482152	1.689231374	-0.571911466
base variant	-3.471927079	-0.508580175	2.254934172	1.725573082

Figure 7.5: The effect of of a lower real rate of return on investment after 1995 on the redistribution of income between generations.

Note the similarity between this figure 7.5. and the previous 7.4, which is caused by the fact that the average profit of the four generations does not change considerably (from 37.98 in the base variant, to 37.29). The lifetime simulation results shown in tables 7.1 and 7.2.1 are clearly reflected in figure 7.5. In terms of intergenerational redistribution of income, the position of the 1960 generation decreases drastically: from being a 'winner' in the base-variant, it now becomes a 'loser', meaning that its net gain is now less than average. As a zero-sum-game is implemented, this decreasing position of the last generation causes the position of the other generations to increase. Apart from the 1950 generation -whose position does not really change-the other generations' position increases. The conclusion is therefore that a decrease in the rate of return which the pension fund makes on investments from 1995 onwards, would worsen the situation of the last generation (1960) in terms of redistribution of income, whereas it would improve the position of the second generation (1940). In fact, these two generations would trade place: the former would go from being a net recipient of (fictitious) intergenerational redistribution, or a 'winner', to a position where it would be a net contributor, or a 'loser', whereas the situation would be the opposite for the latter.

7.2. Variant 3: Replacing the exogenous contribution rate prior to 1995 by the base-rate premium.

In the pension fund prior to 1995, the contribution rate was set exogenously by the Minister of Social Affairs. However, merely for internal purposes, actuarial employees of the ABP developed a base-rate premium equalizing the expected future pension benefits and expected future contributions for the first-year participants in the pension fund. The model of the ABP which is incorporated in NEDYMAS simulates this fictitious contribution rate. Figure 7.6 compares the actual exogenous contribution rate with this base-rate premium.

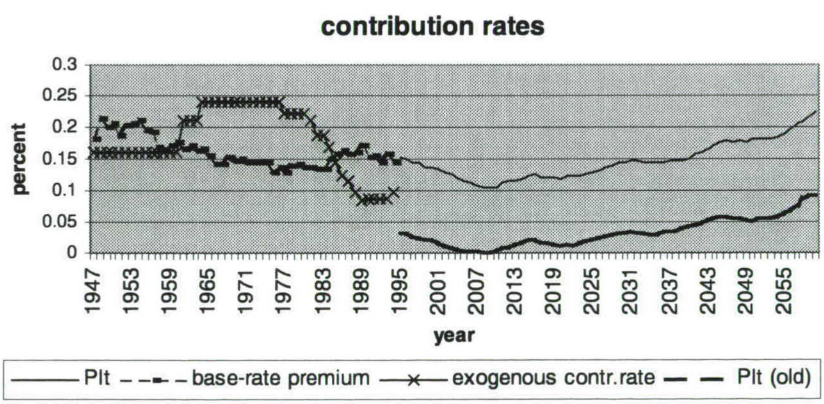


Figure 7.6

It was argued in the previous chapter that this base-rate premium was below the historical contribution rate for a considerable number of years. In this variant, we consider what would have happened to the lifetime income of the various generations under consideration if contributions made to the pension fund were based on the base-rate premium instead of the exogenous contribution rate. First, what would have happened to the development of assets in this case? Figure 7.7 shows that the lower base-rate premium has a profound effect on the development of assets in the simulation period up to 1995, in the sense that assets develop to a much lower level than they would otherwise have done. So, figure 7.6 shows that the resulting long-term contribution rate over the period from 1995 onwards therefore becomes much higher than in the case of the base-variant. This difference varies between 10 and 13 %-point and is on average 11.4 %-point. However, one would expect this higher contribution rate to cause assets in this variant to converge back to the level which it had in the case of the base-variant i.e. with an exogenous contribution rate. As a result, we would expect contribution rates to converge as well. This, however, is not confirmed by the simulation results. Figure 7.8 shows the positive relative difference between the contribution rate in the case of the endogenous base-rate premium (i.e. variant 3) and the contribution rate in the case of the base-variant[48].

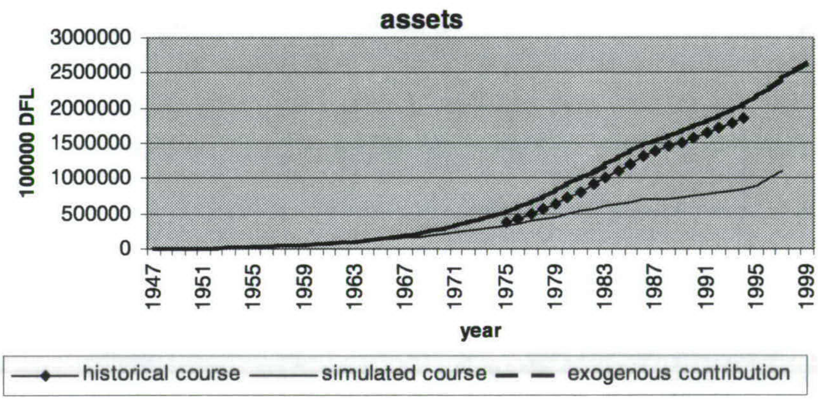


Figure 7.7

At first, the contribution rates converge (i.e. the difference becomes smaller). This is confirmed by figure 7.7 where it can be seen that assets converge from 1995 onwards. However, as from about 2015, the difference increases again, causing the assets to diverge again. What causes this divergence? The answer lies in the sudden increase of the growth rate of the contribution base and the effect which this has on the contribution rate. Denote N the actuarial pension claim, A

[48]The percentage-point difference is written as a fraction of the contribution rate in the third variant, since the contribution rate of the base variant at some point comes close to zero, thereby causing the relative difference to act discontinuously.

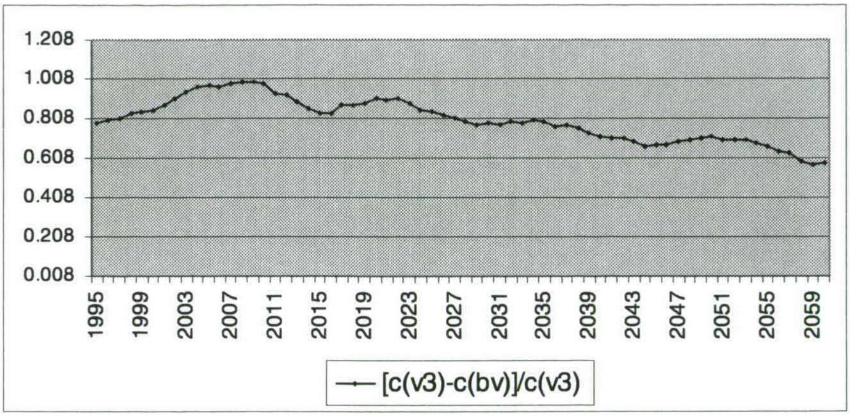


Figure 7.8: relative distance

the level of assets and *CB* the contribution base. Then the contribution rate *c* is determined by $c=(N-A)/CB$. The derivative of *c* to *CB* can be written as $dc/dCB = -[(N-A)/CB^2]dCB$, so that an increase of *CB* results in a decrease of *c*. The second derivative of *dc/dCB* to *(N-A)* can be written as $dc/(dCBd(N-A)) = -[dCB/CB^2]d(N-A)$. In other words, the higher *(N-A)* is, the stronger the negative effect of *SB* on *c* (and therefore on the course of assets) will be. Denote $(N-A)^{bv}$ and $(N-A)^{v3}$ the difference between *N* and *A* in the base-variant (with the high exogenous pre-1995 contribution), respectively the third variant (with the lower endogenous base-rate premium). Then we know from figure 7.7 that $(N-A)^{bv} < (N-A)^{v3}$ given *N*. As a consequence, we know that $[dc/dCB]^{bv} < [dc/dCB]^{v3}$. In words, the negative effect of an increasing *CB* on the contribution rate *c* is stronger in the third variant than in the base-variant. The line of reasoning is as follows: as a result of the sudden increase in the growth rate of *CB*, the growth rates of both contribution rates will decrease, with the result that the growth of assets will slow down. However, this effect is stronger in the case of the third variant than the base-variant, so both contribution rates will converge (remember that the contribution rate in the third variant is higher than that in the base-variant). This in turn will slow down or even reverse the convergence process of the course of assets in both variants. It is possible that it is the fact that the speed of increase of the expected discounted contribution-base increases, which causes the assets to deteriorate even further in this variant (figure 7.5) without this being neutralized by a stronger increase of the contribution rate. This would suggest that the development of assets which figure 7.6 shows, is closer to its 'natural development' would there have been no exogenous contribution rate. Anyway, it at least shows immediately the enormous importance of which contribution rate was used in the first decades of the simulation period. This sets a pattern for the development of assets, which is enforced by the constant rate of return and which is too strong to be neutralized by changes in the contribution rate. Put differently, once such pattern of assets is 'set in motion' by the rate of return on these assets, the effect of changing the contribution rate is limited.

Now what is the effect of using the base-rate premium instead of the historical contribution rate on the net-profit which the four generations under consideration get out of the pension fund? As before, the benefits and contributions as a percentage of the civil servants' annual wage are shown in table 7.3.

Table 7.3: lifetime simulation results.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	18.70	23.76	25.17	24.86
total yearly WW&O pension benefit	16.84	16.92	15.82	17.39
total yearly benefit (ex. Ret.pay)	45.11	52.03	51.44	51.17
total yearly old-age and WW&O-pension contribution	10.65	10.58	10.69	10.83
total yearly contribution	10.95	12.04	13.25	14.09
total yearly benefit minus contribution	34.16	40.00	38.19	37.08

The next table 7.4. shows the same simulation results, but then expressed relative to the simulation results of the base-variant.

Table 7.4. lifetime simulation results: difference with base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	0.979	1.032	0.995	1.019
total yearly WW&O pension benefit	0.999	1.139	0.992	0.917
total yearly benefit (ex. Ret.pay)	0.978	1.068	1.000	0.998
total yearly old-age and WW&O-pension contribution	0.943	1.080	1.220	1.267
total yearly contribution	0.942	1.069	1.184	1.217
total yearly benefit minus contribution	0.990	1.067	0.949	0.934

With regard to the lifetime pension benefits, the same conclusions as drawn in paragraph 7.2. hold. The differences between these old-age and WW&O pension benefits and those of the base-variant are very limited and do not show a distinct pattern. The only exception is the higher yearly WW&O-pension benefit for the 1940 generation. However, as these are not very important figures, the relative differences show more important than they are.

Table 7.5. t-value for the difference with the base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	0.054	0.649	-0.530	0.398
total yearly WW&O pension benefit	0.061	0.665	-0.143	-0.727
total yearly benefit (ex. Ret.pay)	0.016	0.841	-0.254	-0.200
total yearly old-age and WW&O-pension contribution	-0.958	2.584	3.599	3.474
total yearly contribution	-0.954	2.355	3.238	3.364

This is the reason why the total yearly lifetime pension benefit in this variant is very close to the equivalent percentage in the base-variant. As a result of replacing the exogenous contribution rate with the base-rate premium, the annual contributions end up considerably lower between about 1963 and 1987, as figure 7.6. shows. As a result, via the lower level of assets, it can be expected that contributions of the later generations end up higher than in the base-variant. All this is confirmed by the above tables 7.3 and 7.4. The lifetime old-age and WW&O-pension benefit of the 1930 generation end up about 6% lower as compared with the base-variant. For the 1940 generation, lifetime contributions do not change considerably, but for the last two generations, the lifetime contributions end up respectively 22% and 26% higher. As done in the previous simulation variant, we start by depicting the last row of table 7.4 in figure 7.9. We would expect that the first two generations would gain, and the last two generations would lose relative to the base-variant, where the exogenous contribution rate was used before 1995. When looking at figure 7.9, it is surprising to see that the effect on the position of the 1930 generation is small, considering the discussion of table 7.4. It is true that the contributions paid by this generation decrease relative to the base-variant. The lifetime benefits of this generation, however, decrease somewhat as well, thereby neutralizing the effect of the lower contribution[49]. But then how would we explain the fact that the above-average profit of the second (i.e. 1940) generation increases that much? First of all, one should realize that this effect is very small and not significantly different from zero (tables 7.4 and 7.5). Moreover, the same explanation again holds, though in a different direction: as for the old-age and WW&O-schemes, it is true that the lifetime contributions increase relative to the base-scenario. But so do the benefits, and as the latter is higher than the former, the profit which the 1940 generation gets from the old-age and WW&O-pension scheme, increases. As for the last two generations, the increase in the lifetime

[49] It is true that the relative decrease of contributions is larger than the relative decrease of benefits, but as the latter is more important than the former (benefits in the two variants are larger than contributions), so these effects cancel each other out.

contributions clearly becomes that large that it causes above-average lifetime profits to decrease, irrespective of the relative changes of lifetime pension benefits.

Next, we consider the intergenerational redistribution of income. As is the case in figure 7.5, the pattern resembles very much the profits which generations get from the pension fund.

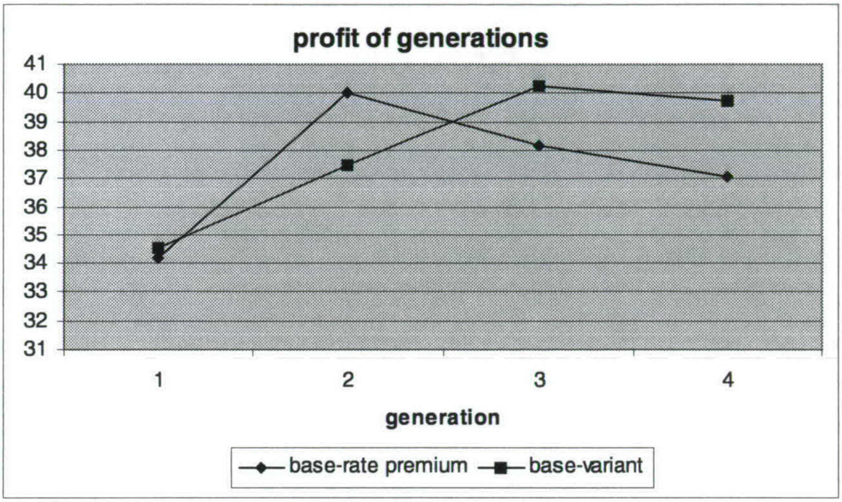
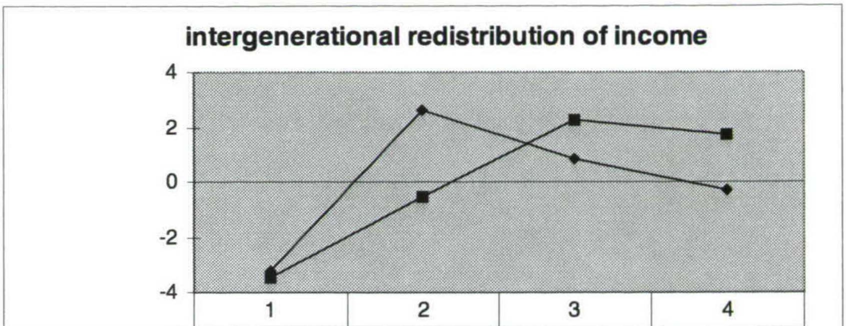


Figure 7.9: The effect of introducing the base-rate premium on the profit of generations.

Again, this is caused by the fact that the average profit does not change considerably (from 37.98 to 37.35). The only effect is that differences are magnified (relative to figure 7.9) and that 'winning' and 'losing' generations are distinguishes.

What does figure 7.10 on the next page teach us? The most important is that, as a result of replacing the exogenous contribution rate by the endogenous base-rate premium, causes the 1940 generation to change from being a 'loser' to a 'winner' in the sense that this generation now has a positive above-average profit. As said when discussing figure 7.9, the profit of the last two generations decreases. This causes the 1960 generation to shift in the opposite direction to the 1940 generation: it now has a less-than-average profit.



	1	2	3	4
base-rate premium	-3.194535586	2.639374954	0.83605592	-0.280895288
base-variant	-3.471927079	-0.508580175	2.254934172	1.725573082

Figure 7.10: The effect of introducing the base-rate premium on the redistribution of income between generations.

7.3. Variant 4: A dynamic pension scheme.

One of the conclusions reached in paragraph 6.2.2 - the presentation and discussion of the simulation results of the base-variant-, was that the oldest generation gained considerably less out of the civil servants' pension fund ABP than the other generations and that this was caused by the high exogenous contribution rate of before 1995. In this paragraph, we will try to find further proof of this, by imposing the privatized- or 'post-1995' version of the pension fund for the whole simulation period. Put differently, we act as if the pension fund was a private organization from the beginning of the simulation period. What will be the effects of this variant, relative to the base-variant? First of all, we can expect that the ratio of benefits-to-contributions of (especially) the oldest generation will increase for the reasons I have just given. And what else? One of the conclusions we based on figure 7.4 in the last paragraph was that changes in the contribution rate at the beginning of the simulation period had a profound effect on the development of assets during the rest of the simulation period. We can expect the long-term contribution rate to be below the exogenous contribution rate, so we can expect the level of assets in this variant in a certain simulation year to be lower than in the case of the base variant. As a result, the long-term contribution rate after 1995 will be higher than in the case of the base-variant. Remember that in the first variant, the first and second generations were considered losers, meaning that they received less than average lifetime-profit from the pension fund. By definition, at least one of the last two generations received more than average: they were considered winners. In this variant, we expect the pension contribution rate to be lower than in the base-variant. Consequently, if the above line of reasoning were true, we would expect the position of winners and losers in terms of positive and negative above-average profit from the pension fund will change in relation to the base-variant. Firstly, we consider the development of assets, as depicted in figure 7.11. It is not very surprising that assets are below both the historical level and the simulated level in the base-variant. As opposed to this base-variant, assets are now a function of actuarial pension information not from 1995, but from 1948 onward. Figure 7.12. again shows the development of assets, but this time together with the expected discounted pension claim and the discounted expected contribution base. Of course, from 1995 on, the level and therefore the development of these last variables is exactly the same as in the case of the base-variant (figure 8.9.), so the course of assets in this variant and in the base-variant will converge in the long run. However, for reasons explained in section 7.2, the development of the expected contribution base SOMB disturbs this convergence, so that full convergence will not be reached before the end of the simulation period. The denominator of the long-term contribution rate, SOMB, shows a remarkably discontinuous increase in the year 1995. This is caused by the change of the exemption from ten-sevenths of the AOW to fl. 26,500. It is true that this affects both the discounted future contribution base as well as the discounted future pension benefit, but we can expect it to be much stronger on the former, as it is based on the actual wage of the individual, instead of the expected final wage. Figure 7.13 shows the endogenous contribution rates, which are a function of the variables depicted in figure 7.12. Generally speaking, the course of the contribution rate is as expected: it is lower than the exogenous contribution rate of before 1995, but as this resulted in a decrease of the level of assets relative to the base-variant (see figure 7.8.) the resulting contribution rate after 1995 turned out higher. This indeed means that we can expect the position of the first generation in particular to improve relative to that of the last two generations.

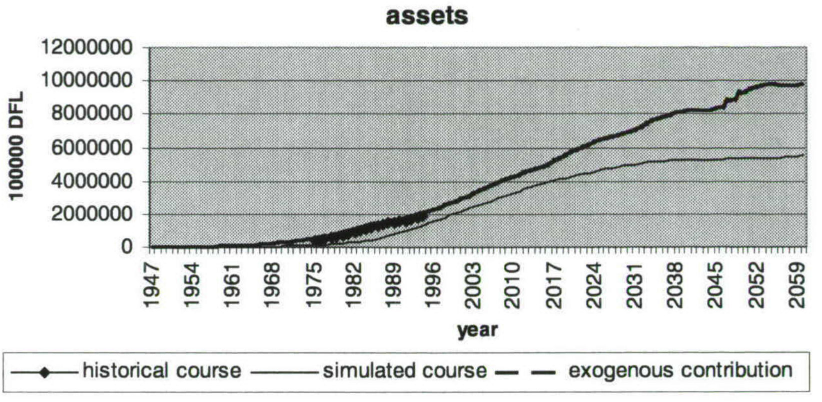


Figure 7.11.

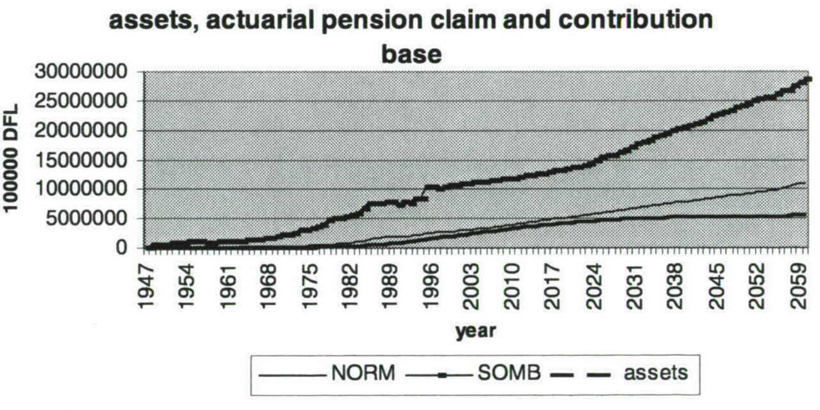


Figure 7.12

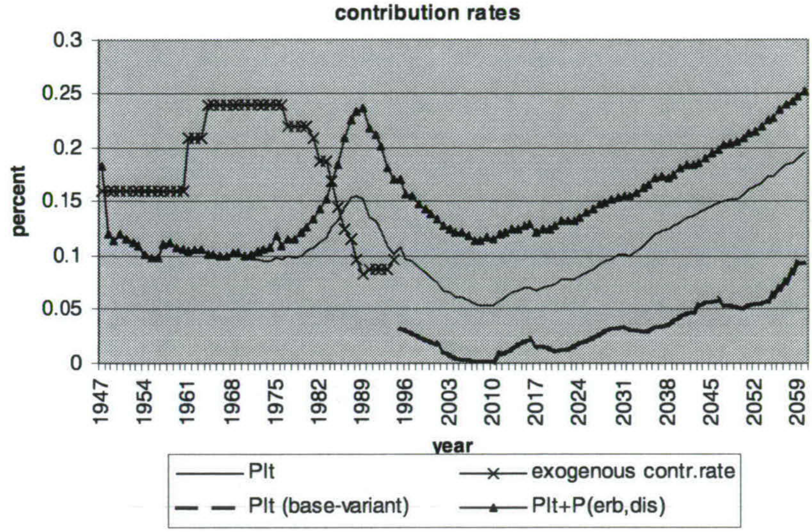


Figure 7.13

Moreover, this positive difference between the endogenous contribution rates in the base variant and the variant currently under consideration, increases as a result of the lowering of the growth rate of assets relative to that of NORM, the discounted future pension claim, even given the fact that the growth rate of the discounted future contribution base increases[50]. Before turning to the other contribution rates, let us dwell for a moment on the development of the endogenous contribution rate in the beginning of the nineties. An explanation for the sudden decrease after 1995 has been given. Explaining the increase of the long-term contribution rate in the earlier nineties, is more difficult. First of all, starting in the second half of the eighties, the number of civil servants first stabilized and then decreased, as said when discussing figure 7.2. Then, in 1989, the National Postal and Telegraph Service (P.T.T.) became a private organization. This had several effects for the pension fund ABP. First of all, the number of active participants decreased by about 8%, whereas the number of old-age (and other) pension beneficiaries remained the same. So, the number of contributors decreased relative to the number of

[50] Based on the diverging courses of the contribution rate in the base-variant and this variant, one could conclude that the effect of this change of the future contribution base on the contribution rate differs between both variants. This, however, would be wrong, since the change in the growth rate has an effect on the growth rate of the contribution rate, not the level itself. Given a different starting position, this will cause the levels of the contribution rates to diverge.

beneficiaries, and this at a time when the return on assets started to decrease. The combination of these effects probably caused the endogenous contribution rate to increase, until 1995 -as said- when the discontinuous change of the contribution base caused a sudden decrease in the contribution rate.

Finally, let us consider briefly the development of the PAYG-contribution rate for covering the costs of disability pensions and ERB. This development does not seem very reliable. Two things can be said: first of all, the simulation results in this fourth variant seem to suffer from the same overestimation of the PAYG-contribution rate as the base-variant did. Fortunately, this does not jeopardize any conclusions, since its effect points in the same direction as the other contribution rates do: an implicit redistribution of income from the later generations to the earlier generations. The second interesting thing about this PAYG-contribution rate is the 'bump' in the beginning of the nineties. This development is clearly caused by the development of the number of early-retirement beneficiaries (ERB) and to a lesser extent by the number of disabled civil servants (figures 8.5 and 8.3, respectively). Note that the annual contributions which individuals make to the pension fund is a function of the sum of both the endogenous long-term contribution rate and this PAYG-contribution rate. As both these contribution rates reach a maximum in 1995 and taking the overestimation of the PAYG-contribution rate into account, the sum of the two ends up quite high and at one point even becomes higher than 20%.

Having discussed the most important pension fund-wide simulation results, we turn to the lifetime-incomes, contributions and benefits. These are shown in table 7.6.

Table 7.6: lifetime simulation results.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	20.14	23.65	25.17	24.36
total yearly WW&O pension benefit	18.06	13.47	15.82	16.86
total yearly benefit (ex. Ret.pay)	49.72	49.22	50.95	49.57
total yearly old-age and WW&O-pension contribution	8.82	10.09	10.62	10.93
total yearly contribution	11.06	13.25	14.32	14.75
total yearly benefit minus contributions	38.66	35.97	36.63	34.82

As in the other simulation variants, the change in the lifetime simulation results in relation to those in the base-variant are shown in table 7.6. Moreover, table 7.7 shows the t-values of the differences between the lifetime per-guilder values. There is no reason why the lifetime pension benefits would change in this variant, and this is confirmed at least by the lifetime old-age and WW&O-pension benefit. However, in this case, even though the simulation error in these schemes is small, it points in a certain direction. There is an overestimation for the first two generations and an underestimation for the last two generations. Table 7.7 shows the ratio of the lifetime-benefits and contributions in this variant and the base-variant.

Table 7.7: lifetime simulation results: difference with the base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	1.055	1.028	0.995	0.999
total yearly WW&O pension benefit	1.071	0.907	0.992	0.889
total yearly benefit (ex. Ret.pay)	1.078	1.010	0.991	0.966
total yearly old-age and WW&O-pension contribution	0.781	1.029	1.212	1.278
total yearly contribution	0.952	1.177	1.280	1.273
total yearly benefit minus contributions	1.120	0.960	0.910	0.877

As was the case in the previous simulation variants, the various pension benefits, as a percentage of the lifetime yearly civil servants' wage, do not change considerably. It is also expected that the lower pre- 1995 contribution rates of figure 7.10, accompanied by the higher post-1995 contribution rates (both as compared to the base-variant, of course) have a strong effect on lifetime old-age and WW&O-contributions. For the 1930 generation, this contribution ends up at 8.82%, which is about 78% of its level in the base-variant.

Table 7.8: t-value of the difference with the base-variant.

generation	1930	1940	1950	1960
total yearly old-age pension benefit	0.374	0.558	-0.026	-0.219
total yearly WW&O pension benefit	0.140	-0.458	-0.027	-0.957
total yearly benefit (ex. Ret.pay)	0.358	0.190	-0.101	-0.720
total yearly old-age and WW&O-pension contribution	-5.458	-6.801	4.514	4.391
total yearly contribution	-1.292	4.725	6.194	5.091

This is the only generation for which the lower contribution rate of before 1995 lowers the lifetime contributions. Note, however, that table 7.7 indirectly shows that the lifetime disability and ERB-contribution for this 1930 generation (and other generations) increases in relation to the base-variant. This is, of course, the result of the fact that in the base-variant and before 1995, no contributions to these schemes were made. This also explains why this indirect effect of the disability and ERB-contribution rate decreases for younger generations. For the 1940 generation, the decrease in the contribution rate before 1995 and the increase afterwards more or less cancel each other out. For the last two generations, the lifetime contribution ends up at about 20 and 28% higher, respectively.

When looking at the last row of table 7.6, it can be seen that if the pension fund ABP did not have an exogenous contribution rate before 1995, i.e. if this fourth simulation variant had been real, the lifetime profit of the 1930 generation would have ended up 12% higher, whereas the profit of the younger generations would have been 4, 9 and about 12% lower. This is shown in figure 7.14, where these profit percentages are presented.

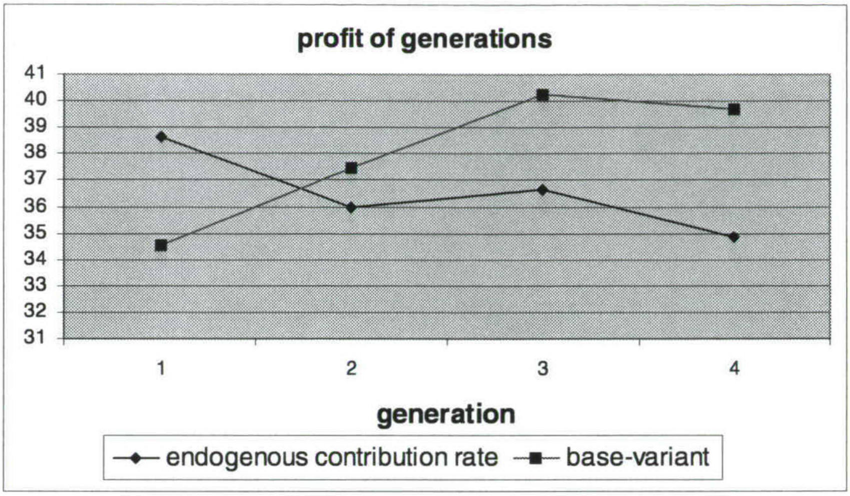


Figure 7.14: the effect of the privatized ABP on the profit of generations.

This figure clearly shows how the pattern of profits has changed as a result of abolishing the exogenous contribution rate of before 1995. The profit of the 1930 generation increases strongly, at the expense of the 1950 and 1960 generations. What is interesting is the effect of this variant on the redistribution between generations. This is shown in figure 7.15 on the next page. Note again the similarity between this figure 7.14 and figure 7.15, showing that the average profit of the four generations does not change considerably (in fact, it decreases by about 4% from almost 38% of the lifetime wage in the base-variant, to 26.5%). As in the other variants, this figure shows what was expected on the basis of the pension fund-wide information. In tables 7.6, 7.7 and 7.8 it was shown that the endogenous contribution rate in this variant remains considerably below the historical exogenous contribution rate of before 1995. As a consequence, the endogenous contribution rate from 1995 onwards is above the endogenous contribution rate in the base-variant. Clearly the position of the 1930 generation improves in relation to the other generations. In fact, instead of being the major 'loser' in the sense that the negative difference between the profit of this generation and the average-profit was maximal, this generation now

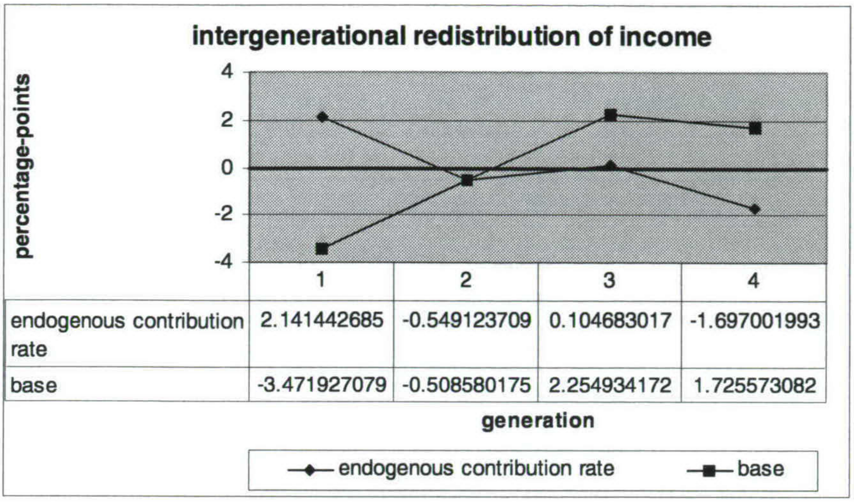


Figure 7.15: The effect of the privatized ABP on intergenerational redistribution of income.

becomes the main 'winner'. Again, as a zero-sum-game is imposed, this important increase of the position of the first generation must be compensated for. This compensation is provided not so much by the 1940 generation, but mostly by the two main 'winners' in the case of the base-variant: the 1950 and 1960 generations. The last generation in particular sees its above-average profit deteriorate, and now becomes one of the main 'losers' in terms of intergenerational redistribution of income.

One last thing must be clarified before turning to the discussion of the dispersions of income. Comparing figure 7.5 with figure 7.13 shows that the base-rate premium, which is based on the actuarial information of first-year civil servants and which forms the basis of the simulation results in the third variant, is higher than the sum of the long-term contribution rate and the PAYG-contribution rate in the fourth variant. This is from the beginning of the simulation period until about 1985 when the effect of the increasing number of disability pensioners and early retirement beneficiaries really kicks in. Why is this? On the one hand one would expect the base-rate premium to be lower than the long-term contribution rate, since the former is based on the future pension claim of the first-year participants for whom this claim is by definition further in the future, and therefore more heavily discounted than the pension claim for the 'average participant in the fund', whose actuarial information forms the basis of the long-term contribution rate. One would on the other hand expect the long-term contribution rate to be lower than the base-rate premium, since the former is based on the actuarial pension claim minus assets, whereas the latter is not, and given the fact that the continuation premium as used here is a fund-wide version of the constant annual premium (as was explained in the first part of this book. See also Roodbol, 1990, pp. 127-138), the weight of these countering effects depends on the age-distribution of the civil servants and pension-beneficiaries. But the actual reason for the positive difference between the base-rate premium and the long-term contribution rate is much more straightforward, and is that the former is based on the actuarial information on all four of the relevant pension benefits (old-age, WW&O, disability and ERB), whereas the latter is only based on the expected future old-age and WW&O-pension claim.

As this fourth variant is more fundamental than the other variants whose simulation results were compared with the base-variant, let us end the discussion of this variant by briefly considering the effect of adopting the 'privatized pension fund' instead of the historical pension fund on the inequality of income. What would we expect the difference with the base-variant to be? The difference between the two variants basically means replacing one contribution rate (the exogenous one) for another (the dynamical one) in the period before 1995. As a consequence, the contribution rate from 1995 onwards changes as well. So, any difference in the income inequality between these variants should be found in the effect of contributions and not in the effect of pension benefits on the dispersion of income. In fact, relative to the base-variant, the pre-1995 contribution rate decreases whereas the post-1995 contribution rate increases. So, roughly speaking, we would expect the decreasing effect of the old-age and WW&O-contribution rate to be weaker in this variant than in the base variant for, say, the first two generations and stronger for the last two generations. In theory, that is. But as the effect of the pension contributions on income inequality is at best rather weak in the base-variant (see tables 6.13 and 6.14) it is questionable if we will find strong empirical proof for the above line of reasoning. Table 7.9 shows the three measures of dispersion (Theil-coefficient, Gini and decile ratio) in this fourth simulation variant. As could be expected, the same pattern appears as in table 6.13. The income inequality of the gross yearly wage as a civil servant is very high for the first generation and decreases strongly afterwards. This is not unexpected, in the sense that the magnitude of the effect remains unexplained. The increasing effects of the various lifetime pension benefits as well as the decreasing effect of the lifetime contributions is not surprising either.

Table 7.9: The effect of lifetime benefits and contributions on the dispersion of income in the case of the privatized ABP.

generation	1930			1940		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	0.235	0.374	5.078	0.164	0.312	3.201
wages plus old-age pension benefits	0.274	0.400	5.941	0.192	0.336	3.528
wages plus WW&O pension benefits	0.408	0.437	5.127	0.275	0.366	3.383
wages plus total pension benefits	0.425	0.462	6.290	0.312	0.394	3.872
wages minus old-age and WW&O-contributions	0.224	0.364	4.892	0.147	0.296	2.973
wages minus all contributions	0.217	0.359	4.756	0.140	0.288	2.883
wages plus all benefits minus all contributions	0.438	0.463	6.070	0.321	0.392	3.669

generation	1950			1960		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	0.145	0.295	2.990	0.122	0.273	2.773
wages plus old-age pension benefits	0.165	0.314	3.201	0.138	0.288	2.950
wages plus WW&O pension benefits	0.279	0.356	3.185	0.253	0.335	2.926
wages plus total pension benefits	0.286	0.375	3.526	0.251	0.349	3.205
wages minus old-age and WW&O-contributions	0.129	0.278	2.782	0.110	0.258	2.603
wages minus all contributions	0.122	0.271	2.698	0.105	0.253	2.540
wages plus all benefits minus all contributions	0.298	0.374	3.377	0.267	0.352	3.095

Even the apparantly wrong positive effect of the total lifetime contributions on the inequality of income-plus-benefits-minus-contributions when compared to the inequality of income-plus-benefits (which was showed to be statistically insignificant) is replicated in this simulation variant. But it is difficult to compare the decreasing effect of the contribution rate in both variants. So, the next table 7.10 shows the t-value of the difference between the effects of contributions in this fourth variant and the base-variant.

A priori, we would expect that this variant should not have any effect on the inequality-increasing effect of the various pension benefits, since these benefits themselves do not change considerably. This expectation is confirmed. For no combination of generation, type of benefit and inequality measure could an important t-value be found. The picture however changes if we consider the lifetime contributions of the four generations.

Table 7.10: The effect of lifetime benefits and contributions on the dispersion of income in the case of the privatized ABP: the t-values.

generation	1930			1940		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	0.423	0.482	0.560	0.552	0.452	-0.089
wages plus old-age pension benefits	0.944	0.898	0.774	0.517	0.543	0.359
wages plus WW&O pension benefits	0.259	0.368	0.283	-0.550	-0.370	-0.418
wages plus total pension benefits	0.435	0.681	0.616	-0.101	0.025	0.254
wages minus old-age and WW&O-contributions	0.147	0.216	0.599	-0.723	-0.949	-1.558
wages minus all contributions	-0.196	-0.153	0.368	-1.185	-1.481	-2.143
wages plus all benefits minus all contributions	0.358	0.526	0.397	-0.177	-0.241	-0.646

generation	1950			1960		
	Theil	Gini	DR	Theil	Gini	DR
gross yearly wage as civil servant	-0.540	-0.623	-0.426	-0.503	-0.268	0.690
wages plus old-age pension benefits	-0.765	-0.737	-0.475	0.450	0.370	0.731
wages plus WW&O pension benefits	0.387	-0.149	-0.267	-0.472	-0.994	-0.157
wages plus total pension benefits	0.070	-0.192	-0.694	-0.164	-0.456	-0.147
wages minus old-age and WW&O-contributions	-1.629	-1.822	-1.645	-1.093	-0.965	-0.188
wages minus all contributions	-1.753	-1.997	-1.850	-1.038	-0.919	-0.200
wages plus all benefits minus all contributions	0.142	-0.278	-1.250	-0.017	-0.324	-0.604

But let us first recapitulate what to expect. As a result of implementing the endogenous long-term contribution rate in this fourth variant, the lifetime contribution of the 1930 generation decreases whereas that of the younger generations increases relative to the base-variant. Moreover, the younger the generation is, the stronger this effect turns out to be. So, in terms of income inequality, we can expect that the inequality of lifetime income-minus-contributions will increase relative to the base-variant (i.e. a positive t-value) whereas it will decrease (i.e. negative t-values) for the younger generations.

Table 7.10 shows that this first expectation is not met. The t-values reflecting the effect of these lower lifetime contributions are all very small and therefore inconclusive. Empirical evidence for the second expectation is considerably stronger and suggests that the higher contributions for the later generations indeed have a inequality-decreasing effect, all relative to the simulation results of the base-variant. It is however somewhat strange that this effect is the greatest for the

1950 generation and not -as we would have expected- for the 1960 generation. Why this is unfortunately remains unclear.

Part IV:

Summary, conclusions and outlines for further research.

This third and last section starts with an extensive summary of the book. Next, the conclusions will be formulated. Specifically, the two questions as given in the introduction will be answered. Lastly, some ways in which this study could be improved will be discussed.

There is an increasingly greater awareness that pensions financed by Pay-As-You-Go systems cause intergenerational redistribution of income. For, in these schemes, active generations contribute to cover the pension benefit paid out to retired generations. It was shown in paragraph 2.3 that the real rate of return of a PAYG-scheme is equal to the growth of the population. So, given a certain individual pension benefit, generations which contribute when there is a high population growth rate, gain relative to generations which contribute when population growth is low. Likewise, it is commonly thought that this kind of redistribution of income does not occur via Capital Funding (CF) pension schemes. In the same simple context in paragraph 2.3, it was shown that the real rate of return of a CF pension scheme is the real interest rate: every generation covers for its own future pension benefit. So, no intergenerational redistribution occurs. However, there are several practical reasons why redistribution might occur in Capital Funding schemes. The actuarially-fair contribution rate was defined to be the age-dependent contribution rate which -if applied- would result in no intergenerational income redistribution. In other words, the actuarially-fair contribution rate is the theoretical contribution rate necessary for every generation to cover exactly its own future pension benefit. It is argued that it is the simultaneous occurrence of ageing and a deviation of the actual contribution rate from the actuarially-fair contribution rate for subsequent generations, which causes intergenerational income redistribution. Or, to put it differently, as a result of intergenerational solidarity, a PAYG-scheme hides in the CF-pension scheme. And, as in the case of 'official' PAYG-schemes, ageing then causes intergenerational redistribution of income. This is based on the assumption that the actual contribution rate is still on average correct for the generations under considerations. On a less theoretical level, however, we will see that intergenerational redistribution can also occur because this last assumption is not met. For instance, we will see that the exogenous contribution rate which was set independently from actuarial notions causes important intergenerational redistribution of income: if current generations contribute too much or too little, future generations will contribute too little or else too much. But why would the actual contribution rate differ from the actuarially-fair contribution rate? First of all, it is possible that the actual contribution rate is not endogenous at all. In fact, before 1995, the contribution rate of the ABP was set by the Minister of Social Affairs. And even if the contribution rate is endogenous, it differs for various reasons from the actuarially-fair contribution rate. This is the second reason. It was argued that the actuarially-fair contribution rate differs with age. Actuarially speaking, a certain uniform increase of the wage should result in higher contribution rates for older participants, since these participants have less years to cover the extra future pension benefits which are caused by the wage-increase. However, in practice, pension funds determine one fund-wide contribution rate which is the same for all participants. As a result, younger generations within the fund cover a part of the extra pension claim of the older generations, i.e. intergenerational redistribution from younger to older generations. A third reason is that expectation errors per definition are shifted to the future: if -for instance- the real rate of return is higher than 4%, the resulting increase of assets will cause over-funding, with the result that the contribution rate will decrease. In this case, there would be redistribution from older generations (who contributed too much in the past, given the higher-than-expected rate of return) to younger generations. Likewise, if there would have been an expectation error which caused assets to end up lower than required (for instance, an overestimation of the real rate of return or an unexpected increase of the number of disabled), which causes intergenerational redistribution of income from younger to older generations.

Having discussed the reasons why intergenerational redistribution might occur, it is important to emphasize again that this might very well be optimal in the welfare sense of the word, since it introduces solidarity between generations.

As a result of the above reasons, one can suspect that intergenerational redistribution of income does occur via pension schemes organized by pension funds. How important is this intergenerational redistribution? And which generations gain or lose from these patterns of intergenerational redistribution of income? These are the questions which this study tries to answer. This, however, introduces some methodological problems. First of all, intergenerational redistribution of the kind just described goes beyond annual redistribution between generations: we need to disentangle the lifetime-income of various generations, and then consider whether or not -and how- the lifetime income of generations changes as a result of introducing a pension fund. We therefore need a model which not only simulates lifetime-income, but also allows for the inclusion of a pension fund. The type of model which meets these requirements is dynamic microsimulation or MSM. In dynamic MSMs, the individual is the methodological point of departure. In a representative cross-sectional dataset, the individuals are described by a number of variables. These variables change as a result of a Monte Carlo process or, as the result of the change in other variables for the same individual, or for other individuals. This way, individuals are born, receive schooling, enter the labour market, retire and die, with certain probabilities that these and other events will actually happen. The Dutch dynamic microsimulation model NEDYMAS (NEtherlands DYnamic MicroAnalytic Simulation system) is developed by Jan Nelissen (Nelissen, 1993, Nelissen, 1994)) and simulates the lifetime-income of four subsequent generations from 1947 to 2060. The first generation included is born between 1930 and 1935. The members of the second and third generations are born between 1936 and 1945, and 1946 and 1955 respectively. The members of the last generation are born between 1956 and 1965. This model is extended with a module representing the Dutch civil servants' pension fund ABP, which stands for Algemeen Burgerlijk Pensioenfonds. The ABP is one of the largest pension funds in the world, with about 980,000 active participants and about 500,000 pension beneficiaries and assets amounting up to 200 billon guilders. So, NEDYMAS determines who becomes a civil servant and what these civil servants earn. Moreover, it simulates which civil servants cease to be so, for instance because they become disabled or because they retire or die. Using this information, the pension fund module determines how much civil servants contribute and how much former civil servants get as a pension-benefit (figure 5.7). The structure of the module is given in figure 5.1. The contribution rate before 1995 was set by the Minister of Social Affairs. However, from 1995 on, the contribution rate became an endogenous uniform (i.e. age-independent) fund-wide version of a constant annual premium. This contribution rate is based on an extensive actuarial model, described in paragraph 5.3., which uses the same transition probabilities as the ABP does (and of which some are presented in figures 5.8 to 5.12).

Figures 6.1 to 6.7 show that the fit of the fund-wide simulation results (such as numbers of active participants and other participants in the fund, assets and so forth) is reasonably good. The number of active participants will decrease slowly until about 2025, after which it will remain more or less the same. The number of old-age pension beneficiaries will increase strongly to more than 120,000 in 2037, after which a decrease will set in. Assets will continue to increase as well, mostly driven by the real rate of return on investments, though the speed of increase will gradually slow down as time goes by. The contribution rate (figure 6.11) will decrease somewhat at first, and then start a gradual increase from about 2010 onwards.

The model simulates the effect of the pension fund ABP on the lifetime subjective-equivalent household-income of subsequent generations of civil servants. However, the income-concept is not the 'classical' household income, since for various reasons, extensively discussed in paragraph 6.2.1, annual incomes, contributions and benefits do not add up to the lifetime-income of the children in the household. Moreover, the household income is made equivalent based on the Subjective Poverty Line (Kapteijn et.al. 1985). Changes of the lifetime-contributions or benefits can be the result of higher per-capita values or of more individuals actually receiving the benefit or paying the contribution. Usually, the lifetime-contributions and benefits are expressed as a percentage of the lifetime civil servants' wage of the civil servants of that generation. The old-age pension benefit is the most important pension benefit, in terms of percentages of the lifetime civil servants' wage. Table 6.2 shows that its importance is gradually increasing from about 19% of the lifetime wage for the 1930 generation, via 23% for the 1940 generation to a maximum of more than 25% for the 1950 generation. For the 1960 generation, it ends up a bit lower, namely between 24 and 25%. The Widows/Widowers- and Orphans pension benefit (referred to as WW&O-pension benefit) is in second place, at almost 17% for the 1930 generation, then decreases to almost 15% for the 1940 generation and recovers to almost 16 and 19% for the 1950 and 1960 generations. The other pension benefits are of lesser importance, although the lifetime disability benefit is still between 6 and 9% of the lifetime wage. On the whole, in the case of the base-variant, total benefits are about 46% for the 1930 generation, then increasing to about 48% for the 1940 generation and finally becoming a bit higher than 51% for the last two generations. When considering lifetime contributions (table 6.3), the most striking observation is that the lifetime old-age and WW&O-contribution is by far the highest for the 1930 generation (over 11%), whereas it ranges between 8 and 10% for the other generations. This is clearly the effect of the exogenous pre-1995 contribution rate. So, when considering the balance of lifetime benefits and contributions in table 6.4, both expressed in 1992-guilders and as a percentage of the lifetime wages, we see that all four generations profit, caused by the real rate of return on investments of assets, but that the profit of the 1930 generation, which is a bit higher than 34%, is considerably below that of the other generations, where the profit ranges between 37% and 40.2%. The profit is the highest for the 1940 generation.

The fact that all generations get more benefits out of the pension fund than they contributed to it, both in terms of lifetime income, makes it less straightforward to draw conclusions concerning intergenerational redistribution of income, for there is no zero-sum-game-situation in which the gain of a certain generation is necessarily neutralized by the loss of another generation. However, by subtracting an average per-guilder gain for the four generations from the actual gain of every generation, such a zero-sum game is imposed. So, the question then becomes "who gains more than average from the pension fund, and who gains less than average?". Figure 6.15 then shows that important intergenerational redistribution of income occurs from the 1930 generation (-3.5%) to the last two generations, and especially the 1950 generation (+2.3%). This pattern is clearly caused by i) the high exogenous rate of return which the pension fund experiences during the eighties (figure 5.6) and which was especially beneficial to the 1950 generation, and ii) the high exogenous rate of return which the ABP used before being privatized in 1995 and which mostly affected the contributions of the 1930 generation. Next, paragraph 6.2.3 shows the effect of transiting from a final wage scheme to an average-wage scheme in the year 2000. Figures 6.12 to 6.14 showed that this transition is not a sudden jump from one scheme to another, but merely a gradual shift, since pension claims gathered in the past remain unaffected. So, if the pension fund decides to replace the final wage scheme by an average-wage scheme in 2000, only in the future years when the fund consists solely of individuals who entered the pension fund from 2000 onwards, will the operation be finished. Table 6.5 expresses the simulation results in the case of this transition as a percentage of the simulation results in the base-variant, both expressed as a percentage of the lifetime-wage. The t-values accompanying this transition are presented in table 6.6. The most important effect of these changes is, as could be expected, that both old-age and WW&O-pension benefits decrease considerably relative to the base variant. The old-age pension benefit remains the same for the 1930 generation, because the members of this generation will have retired before the transition takes place. For the 1940 generation, the old-age pension benefit does not change either. However, for the 1950 and 1960 generations, the lifetime old-age pension benefit decreases by 13%, 24% respectively! The lifetime WW&O-pension benefit starts with a 5% overestimation for the 1930 generation, but then follows the same pattern as the old-age pension benefit: for the 1940 and 1950 generations, it ends up 10% below its value in the base-variant. However, table 6.6 shows that the hypothesis that these changes differ significantly from zero, can not be rejected. For the 1960 generation, this difference increases to 25%, as in the case of the old-age pension benefit. The transition of the wage-base from a final wage to an average-wage naturally has its effect on the expected future pension benefit (figure 6.12), which in turn will cause contributions to decrease (figure 6.13). Table 6.5 shows that the lifetime contributions do not significantly decrease for the first two generations, but end up 10% below their value in the case of the base-variant for the 1950 generation. For the last generation, lifetime contributions decrease by 25% as well. On the whole, only the balance of benefits and contributions of the 1960 generation changes considerably, and decreases by 23% (only old-age and WW&O-benefits and contributions). What is then the effect of this transition in the year 2000 on the redistribution of income between these four generations? Remember that intergenerational redistribution of income required the imposition of the zero-sum-game. This, however, makes comparison between two simulation variants a bit tricky, since it can cause the positions of certain generations to change, even if their actual net-lifetime receipts remain exactly the same. This is because the way in which intergenerational redistribution is represented is by asking the question "how much profit does a generation makes, in relation to the other generations"? So, when comparing the intergenerational redistributional patterns of two simulation-variants, we consider how the profit of a certain generation changes, in relation to other generations. This way, the loss of a particular generation must by definition be covered by a gain of at least one other generation (which after all is the principle of a zero-sum-game). Figure 6.16 shows that the position of the 1960 generation decreases considerably. From being the penultimate 'winner', it now becomes the 'loser'. Instead, the profit of the 1930 generation increases drastically, and this generation now becomes the main 'winner'. Again, these shifts are in relation to the other generations. For instance, the actual position of the 1930 generation does not change at all, but the net benefit of the 1960 generation causes the average profit to decrease, thereby increasing the above-average profit of the 1930 generation. So, as figure 6.17 shows, the profit of the 1930 generation may increase in relation to the average profit, but the profit itself remains fairly stable.

In paragraph 6.2.3, we returned to the base-variant and considered how these results differed for various sub-groups in the dataset. First of all, the differences between male and female civil servants were considered. Next, the differences between civil servants of different educational categories were considered. The number of female civil servants is considerably lower than their male counterparts, as shown in table 6.7. In the first generation, the proportion of women is 62% that of men, which is equivalent to saying that about 62/162=38% of the civil servants are female. This difference becomes smaller for later generations, and in the case of the 1960 generation, the proportion of female civil servants is about 88% of male civil servants. The increasing proportional difference between the lifetime wage of men and women in subsequent generations, however, leads us to suspect that the 'extra' women who were hired in the younger generations, were in the lower career brackets more often than they were before. Moreover, even though the average length of career of women has increased considerably, it remains below that of male civil servants. The proportional difference between the lifetime contributions and benefits of women and that of men is of course to a certain extent caused by the proportional difference between the wages of the two categories. For the first two generations, the lifetime old-age pension benefit of women was about equal to that of men, but for the last two generations it ends up lower than that of men. This could be caused by the lagging length of career of women in relation to that of men. The most striking aspect thing of table 6.7, however, is that the lifetime WW&O-pension benefit is much higher for women than for men. For the 1930 generation, the WW&O-pension benefit is 39 times higher for women! For the later generations, this difference decreases strongly (factor 15, 12 and 6.6 for the 1940, 1950 and 1960 generations, respectively), but it still remains much higher. First of all, men were not eligible for a WW&O-pension benefit before 1987. The second reason is that the benefit which anyone gets, is based on the characteristics of the partner (who is of the opposite sex). As the lifetime civil servants' wage of women is lower than that of men, the WW&O-pension benefit of men must by definition be lower than that of women. Moreover, as there are fewer female than male civil servants, the number of men who are married to female civil servants who die will be lower than the other way around, under the assumption that the mortality rates for men and women are equal. But they are not; mortality rates for men are higher than those for women, which amounts to the last argument. When looking at the lifetime contributions, it may come as no surprise that the lifetime contributions of women are lower than those of men. On the whole, women get more out of the pension fund than men do, and this positive difference is caused by the proportionally high WW&O-pension benefit for women.

In addition to making a difference between men and women, the lifetime-simulation results are also specified to the educational level of the civil servant. NEDYMAS simulates seven levels of education, going from primary school to university. In the context of this model, three broad categories have been used: the first category contains those who have at most a senior vocational training qualification. The second category contains those with vocational colleges qualification and the third category includes those who graduated successfully from university. The simulation results are shown in table 6.9. For the four generations, the relative numbers of civil servants in the first two educational categories are more or less equal, and higher than the relative number of civil servants with university degrees. Moreover, the average length of the career of civil servants in this last category is shorter than that of the other categories. As far as the lifetime wages are concerned, there is a positive relation between level of education and lifetime civil servants' wage. However, these differences between educational categories decrease over generations. The differences between the lifetime old-age pension benefits follow the same pattern as the difference between the lifetime wages, as could be expected. However, these differences are more pronounced, which could be caused by the fact that the exemption is of lesser importance to categories who earn more. The same pattern that lifetime benefits increase with educational level, but that these differences decrease over generations, can also be found for the disability and ERB-pension benefits, but not for the lifetime WW&O-pension benefit. In fact, the WW&O-pension benefit is the highest for the second educational category and is the lowest for the group with university degrees. One of the reasons for this could be a gender effect, in that the proportion of female civil servants is the highest in the second educational category (tables 6.10 and 6.10.2). Next, a distinction is made between men and women in the three educational categories. Again, the figures for women are expressed as a percentage of that of men, but then for the three education categories under consideration. Tables 6.11 and 6.12 first of all show that the increasing number of female civil servants over the generations was accompanied by a relatively decreasing average educational level of the women, in that the increase in female civil servants with university degrees is below average. Only in the last generation is this no longer the case. This, among other reasons, causes the difference between the male and female civil servants' wages to be greater for the higher educational categories. It is the most important determinant for the patterns of the various pension benefits, such as the old-age pension benefit. The development of the proportional differences between the lifetime WW&O-benefit for women and men in the three educational categories is also an exception: it appears that the WW&O-pension benefit is higher for women than for men in all education categories, which could be expected, but that this proportional difference is the largest for the second educational category. Explaining why this is would take us to far, so the reader is invited to read the discussion in the main text.

Lastly, the sixth chapter discusses the effect of the various pension benefits and contributions on the distribution of income, as represented by the Theil-coefficient, the Gini and the decile ratio. This implicitly includes two of the three forms of redistribution as described in section 2.1., namely vertical redistribution and intergenerational redistribution. It appears from tables 6.13 and 6.14 that the lifetime pension benefits cause lifetime-income inequality to increase. This is caused by the exemption. Moreover, for the same reason, lifetime pension contributions have an inequality-decreasing effect on lifetime incomes.

In the seventh chapter of this study, some simulation variants are presented and discussed. In the first simulation variant, the exogenous real rate of return is changed. In the second simulation variant, described in paragraph 7.1., the exogenous contribution rate of before 1995 is replaced by an endogenous 'base-rate premium' which is based on the first-year participants. Next, in the third simulation variant, the pension fund is simulated as if it were a private pension fund (i.e. with an endogenous contribution rate) from the beginning of the simulation period onwards.

In the first simulation variant the exogenous real rate of return decreased from 1995 onwards in relation of its development in the base variant. This negative change is depicted in figure 7.1. and its effect on assets and contribution rates are shown in figures 7.2 and 7.3 respectively. Tables 7.1, 7.2.1 and 7.2.2. show the effect of the lower exogenous real rate of return on lifetime contributions and benefits. Of course, there is no significant effect on the pension benefits. For the first three generations, the lifetime contributions do not change considerably either (which, by the way, again shows that the course of the real rate of return is the most beneficial to the penultimate or the 1950 generation). However, for the 1960 generation, lifetime contributions increase by about 13%. It is unlikely that this change is the result of Monte Carlo variation. Figure 7.4. shows the profit of the four generations under consideration. It can be seen that the profit of the first three generations does not change significantly (see table 7.2.2.), whereas the profit of the 1960 generation decreases. Figure 7.5 shows how the pattern of intergenerational redistribution of income changes as a result of the decreased real rate of return. From being a 'winner', in the sense of being a net recipient of intergenerational redistribution of income, the 1960 generation now becomes a 'loser', meaning that it gains less than average. Given the zero-sum-game-situation, this change must be compensated for, and figure 7.5. shows that the position of the 1940 generation in particular increases considerably.

In the third simulation variant, the exogenous contribution rate of before 1995 is replaced by the base-rate premium. Figure 7.6. shows that the base-rate premium lies below the exogenous contribution rate between 1960 and about 1985, but above it for the years before 1960 and between 1985 and 1995. Figure 7.7 shows that this results in a considerably lower development of assets. Consequently, the endogenous contribution rate from 1995 onwards increases in relation to the base-variant. Tables 7.3, 7.4 and 7.5 show the effect on lifetime simulation results. As was the case in the second simulation variant, lifetime benefits of the four generations are not significantly changed in relation to the base-variant. The same goes for the contributions of the first two generations. For the last two generations, the lifetime pension contribution to the old-age and WW&O-pension system ends up 18% and 21% higher, respectively. As a result of this, the position of the last two generations in particular decreases, both in terms of intergenerational redistribution of income and profit (figures 7.9 and 7.10).

In the fourth and last simulation variant, the 'dynamic pension fund' is considered. So, the pension fund as it appeared from 1995 onwards, is included in NEDYMAS from 1948 onwards. In this way, the disturbing effect of the exogenous contribution rate is excluded. Figure 7.13 shows that the contribution rate of before the eighties decreases (considerably) in relation to the base-variant, thereby suggesting again that the contribution rates were too high before 1980. Figure 7.11 shows that assets decrease in relation to the base-variant, with the result that the contribution rate of after 1995 increases in relation to the base-variant. Tables 7.6, 7.7 and 7.8 show the effect of these changes on lifetime benefits and contributions. As for the previously discussed simulation variant, there is no reason why the lifetime benefits should change. And, indeed, they do not, as table 7.8 shows. The lifetime old-age and WW&O-contributions of the 1930 generation, however, decrease by no less than 22%. The lifetime disability and ERB-contribution rate increases somewhat, but the total contribution of this generation nevertheless decreases by 5%. On the whole, the total lifetime benefit minus contributions of this 1930 generation increases by 12%. The higher contribution rate of after 1995 causes the profit of the 1950 and 1960 generations to decrease by 9% and 12%, respectively. This is also shown in figure 7.14. Figure 7.15 shows how the pattern of intergenerational redistribution of income in this simulation variant changes in relation to the base-variant. It basically shows that the use of the exogenous contribution rate (in the base-variant) caused the 1930 generation to become the main 'loser' instead of the main 'winner'. The main 'winner' in the base-variant, the 1960 generation, loses ground in relation to the base variant, and ends up with a profit which is about equal to the average profit of the four generations. The 1960 generation gets less profits from the high interest receipts in the eighties, in relation to the 1950 generation, and faces an even stronger increase in lifetime contributions. As a result, this 1960 generation now becomes the main 'loser' in this simulation variant.

In the introduction to this book, two 'very simple' questions were formulated. Firstly, does intergenerational substitution of income through pension funds exist? And secondly, what causes these income flows? These questions now have been answered. Yes, intergenerational redistribution of income does occur, and what is more: it is quite important, in terms of discounted equivalent lifetime income. For instance, it can be derived from table 6.1 that the income of the 'losing' generation (the 1930 generation) decreases by about 10% in relation to the situation where all four generations gain the same average value of discounted guilders, whereas the income of the winning 1950 generation increases by about 6%. In the case of the dynamic pension fund (the fourth simulation variant), the relative profits and losses would be smaller, though considerable: the main winner would have been the 1930 generation, which would have gained about 6% in relation to the average discounted income, whereas the main 'loser' would have been the 1960 generation, which would have gained about 5%.

And what are the causes of this intergenerational redistribution of income? The comparison of the above patterns of relative profits and losses also reveals that the exogenous contribution rate as used before 1995 has had a considerable disturbing impact, which appears to have been stronger than the effect of the high real rates of return during the eighties. Partly, this is of course the result of discounting, but the latter effect only took place for at most 10 years, whereas the high exogenous contribution rate appeared for all the years before 1980. This is the second conclusion.

In section 2.3, the causes for intergenerational redistribution of income given a actuarially-based contribution rate were given. These causes boiled down to the conclusion that it was the combination of demographic ageing and the contribution rate not being equal to the actuarially-fair contribution rate which caused intergenerational redistribution of income. In fact, it was argued that the effect of this inequality between the actual and actuarial contribution rate resulted in a PAYG-scheme being hidden in the CF-scheme. Consequently, as in the case of a PAYG-scheme and given the current patterns of ageing, this would result in redistribution of income from younger to older generations. The fourth simulation variant (paragraph 7.3) was designed to show whether this was indeed the case, and these results support this hypothesis. This is the third conclusion.

So, on the whole, intergenerational redistribution of income via the ABP is caused by two historical causes, the exogenous contribution rate of before 1995 and the high interest receipts during the eighties, and one more theoretical case which is that the actuarial fund-wide contribution rate is not the same as the (age-dependent) actuarially fair contribution rate, which is in turn caused by the fact that the fund sets its contribution rate for a group participants which is ageing but also changing in size as a result of hiring decisions by politicians. These two reasons (the historical versus the 'theoretical'), however, cause intergenerational redistribution of income in opposite directions. In this case, the historical causes are stronger than the 'theoretical' causes, resulting in redistribution from old to young generations in the base-variant.

And where do we go from here? Given these conclusions and the model which forms the basis for them, how could knowledge about intergenerational redistribution of income via pension funds be improved? And what improvements on microsimulation models could be made in this context?

A first potential improvement could come from the way in which the simulation variants are calculated, and how they are compared with the base-variant. Usually, developers of microsimulation models routinely use the same starting values for the simulation variants. This way, the Monte Carlo variance is by definition minimal, and comparison of the simulation results with those of the base-variant is easy. In this study, however, the choice was to use an ongoing random selection of starting values. The reasons for this were explained in the fourth appendix, but the most important reason is that I think it is the only way in which the quality of the model could be brought under the spotlight. However, the wrong conclusion may have been made, and one could also see this decision as opening a discussion on the use of starting values in microsimulation. In a broader context, it could be said that there is great need to develop some 'how-to' standards in microsimulation, some discussion on technical issues in both static and dynamic microsimulation[51] and maybe on how these issues could be standardized. Not only would this greatly shorten the time it takes to develop a microsimulation model, but it would also make these models more transparent and less a 'black box', which is one of the ultimate goals for all scientists.

Secondly, improvements could be made in the way in which intergenerational redistribution of income was measured in this study. This was done by considering how much profit every generation had made by contributing to the pension fund, and then implementing a zero-sum game by subtracting the same average profit for the four generations from these profits. This way, the balance of intergenerational redistribution flows is zero. This technique requires some improvement in three respects.

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[51] The author has been involved in static microsimulation as well (Dekkers, 1999(c), and forthcoming(b)) and has run into the same problems, requiring several 're-inventions of the wheel'.

First of all, it implies that redistribution between these four generations and other preceding or succeeding generations does not occur. This is of course an enormous simplification of the facts, since we are only considering four generations in an infinite 'string' of generations. So, a first improvement would be if a method could be developed which required a less strict assumption than the zero-sum game.

The second way in which this technique could be improved is related to how the zero-sum game is implemented. As said, this is done by subtracting the average profit of all four generations from the specific profit of these generations. This is a simplification as well, since it assumes that the situation in which no generational redistribution of income would occur, would be one in which every generation would make exactly the same amount of profit, relative to their lifetime civil servants' wage. It would be better to find a way of dropping this assumption of a constant profit for different generations and link the profit of generations, not as a constant percentage of lifetime wages, but, say, as a constant percentage of lifetime contributions. More specifically, it would have been better to assign interest receipts made in a certain year to the generations which supplied the assets used to invest, and generate, the profit. This would be more in line with the equivalence-principle. Moreover, this could also mean that the requirement of a zero-sum-game would be dropped, thereby allowing for redistribution between the four generations under consideration with preceding or succeeding generations. However, this would also mean an important diversion from the actual pension fund model which is described in this book. In this model, the interest receipts which the fund generates increase assets and therefore decrease contributions. So, interest receipts generated in a certain year and implicitly generated by past contributions of current and past active generations are assigned to current and future active generations. This way, in fact, the above model misses some intergenerational redistribution of income from earlier to later generations. But if we were to find a way to assign interest receipts to past generations, we would also find a way of *not* assigning these profits to current and future generations. This would require doing away with the dynamic contribution rate as described in this book, or (at least) it would mean that this contribution rate would be a function of the expected future discounted pension claim and assets *minus that part of assets which is assigned to past generations*.

Another potential improvement of the model could be in the field of interactively linking the microsimulation model to a macroeconomic model. As said in another study (Dekkers, 1999), I have tried to do so, but this attempt unfortunately failed. An important improvement could be made by making the real rate of return endogenous, for instance by means of a general-equilibrium model. However, making such a macroeconomic model interact within a simulation period with the microsimulation model, requires the macro-model to be very stable, not only in terms of its development over time, but also in terms of the number of iterations needed for convergence at every point.

A last, more theoretical, potential improvement is related to the redistribution of what we are simulating and measuring. Of course, we are dealing with income, but that is not all. We are dealing with discounted and equivalent household income. This clearly was related to a notion of welfare (see paragraph 6.2.1). A lot of work remains to be done in the link between income, redistribution and welfare. Without wanting to mention the whole mass of literature which has been written on this subject (see Slesnick, 1998, Barry, 1990, for an overview), it might be clear that this link between income and welfare could be better. For instance, a welfare function for generations could be developed and linked to the microsimulation model. This way, it could be seen whether or not intergenerational redistribution of income would also mean intergenerational redistribution of welfare. This way, the use of the 'situation without any redistribution' would no longer be used as a benchmark, but could be replaced by a more sophisticated one. Then we could really see, as Ponds argues (Ponds, 1995), whether (intergenerational) solidarity within a pension fund could improve the welfare-level of some or all generations, for instance as a result of risk-sharing.

APPENDICES

Appendix 1: Relation between transition probabilities and - possibilities in the pension fund module.

This appendix consists of one table, table A1.1, where the relationship between the transition probabilities (as presented in the figures 5.8 to 5.12) and the transition possibilities (table 5.1) is given. So, the probabilities in the left column are used to determine the (sometimes compound) probabilities for a certain transition possibility in the right column actually happening.

table A1.1: Relationship between transition probabilities and possibilities.

transition probability	transition possibility (row,column)
1. death prob. active men & women	(1,4) (1,5) (5,5)
2. disability prob. active men & women	-11
3. layoff prob. active men & women	-13
4. retainment pay (25%,50%) active men & women	-13
5. early retirement prob. active men & women	-12
6. death prob. retainment pay, early retirement and non-contributory participating men & women	(3,4) (3,5) (4,4) (4,5)
7. death prob. disabled men & women	(2,4) (2,5)
8. death prob. retired men & women	-55
9. death prob. widows older and younger than 65	not in table
10. frequency of married active men & women at age of death	-15
11. frequency of married disabled men & women at age of death	-25
12. frequency of married retired men & women at age of death	-55

Appendix 2: general and state-specific formulation of the actuarial models of the pension fund ABP.

Appendix 2.1: old-age pension:

Here, the actuarial modelling of the current and future old-age pension claim of various categories of participants will be presented and explained. First of all, the general formulation will be presented, both in the case of the exemption method and the built-in method. The reason why the situation in the case of the exemption method is explained first, even though their 'ranking in time' is the other way around, is that the latter can be presented as a variant of the former. Moreover, since the built-in method is used only from 1960 to 1985, whereas the exemption method is used from 1986 until the end of the simulation period (which is in 2060), the latter is clearly more important than the former. We will start by presenting and explaining the model in a general form. Next, the specific (state-dependent) formulations will be presented.

The first step when the description of the annual upbuilding of the old-age pension cost when the exemption method is used, is to get an idea of the present value of the pension base:

$$PB = \Sigma_{j=65}^{100}\left(\frac{(Q_{RET,D}(65,j))\times(index)^{j-65}\times\left(E(WageBase(65))\right)}{(1+r)^{j-65}}\right) \qquad \textbf{(A2.1)}$$

As explained in the main text, the value PB denotes the fictitious total amount of money which forms the basis of the pension benefit, and of which the individual covers a certain percentage per year provided that he or she is not (yet) retired and participates in some way in the pension fund. Actuarially speaking, PB is the total expected discounted old-age pension benefit from the retirement age onwards: it is the total amount of money the pension fund should have in the year that our individual reaches retirement age, in order to be able to pay the annual pension benefit from that year onwards until the expected age of death of the individual (as is the case for the interest-coverage system). In the formation of PB, $Q_{RET,\,D}(65,j)$ denotes the survival probability of an individual of 65 to j[52]. The variable *index* denotes the current increase of the

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[52] Denote *p(age)* the annual mortality rate, or the probability that an individual of age equal to *age* deceases within a year. For every age, these probabilities are reflected by figures 5.8. and further. Denote *q(age)*=1-*p(age)* the annual survival probability of an individual. For different ages, these probabilities can be assumed to be independent and the probability that an individual of *age* becomes *n* years older, can be written as:

$$Q(age,age+n)=Q(age)\times Q(age+1)\times\ldots\times Q(age+n-1) \rightarrow Q(n,age)=\Pi_{t=age}^{age+n-1}\ q(t)\ =\Pi_{t=age}^{age+n-1}(1-p(t))$$

macroeconomic wage-rate and implicitly represents the expected future cost of indexation. It is assumed that wages increase by 2% per year. E(Wage Base(65)) is the expected wage base which the individual will have at the retirement age. This is the average wage (depending on gender and education) of a 64-year old individual. The exemption is either based upon an expected value of the AOW-benefit or, after 1995, on an amount of money, namely fl. 26,500 in 1995, which is assumed to follow the wage-index over time. The expected pension claim of an individual depends on the probability that he or she reaches a certain upbuilding of this pension base PB. After 40 years, an individual should have formed a pension of 70% of the wage-base. In that case, the total (expected) pension cost is then 70% of the discounted wage-base, totalled for all future years from the retirement age until the expected age of death. In other words, the pension cost is then 70% of the pension base PB.

It was explained thoroughly in the main text that the annual increase of the upbuilding percentage (or, in other words, the upbuilding rate) depends on the situation which the individual is in and has been in for a certain number of years, and the annual rate of upbuilding attached to this state. So, the expected value of the number of participation years times the annual upbuilding rate must be multiplied with the pension base PB.

The general setting of the present value of the current and future old-age pension claims of an active participant is the sum of the extra annual relative pension claims which the individual will gather in the future years between his or her current age and 65. We depart from the total discounted expected value of the various future pension claims, N_t , as it is presented in equation 5.2 in paragraph 5.2.1. This discounted expected total future pension claim consists of discounted expected old-age pensions OP, disability pensions IP (which includes OP^{DIS}, the future old-age pension benefit for those who are disabled) and WW&O-pensions NP. Again, no actuarial measures were taken to cover the cost of the retainment pay and early retirement benefit. Denote β the 'pension-state' which the individual is currently in. Then the present value of the total future old-age pension cost of a certain individual is the sum of the discounted values of the yearly upbuilded discounted pension claim for the future year i, $OP^A{}_i$, which in turn is a function of the pension base PB of the individual. Note that the time horizon of the actuarial model is 35 years (so this is the maximum number of times a value of OP is calculated), which is in line with the time horizon of the actuarial models of the ABP itself. Lastly, remember that

---

This is the survival probability. The probability that an individual of *age* experiences a certain event at age n given that this event did not happen before n is $Q(age4,age+n-1)\text{x}P(n)$.

the additional increases of the future pension benefit as a fraction of the pension base PB (i.e. the 'upbuilding rate') depend on the 'pension-state' β which the individual is in.

To start the specification of OP^{β}, let us depart from the well-known notion of 'expected value' and apply this to the pre-1995 situation. The expected value of a variable is the sum of the probabilities that an event happens times the value of the variable if that event were indeed to take place. Denote *au* the rate of upbuilding i.e. the speed by which the individual gathers a future pension, relative to the speed by which a civil servant gathers a future pension. For instance, each year that a civil servant contributes to the pension fund, his or her future pension claim, as a fraction of the wage-base, increases by 1×1.75%. In this case, *au* equals 1. However, if an individual is, say, an early retirement beneficiary, his or her pension benefit increases at half the speed of that of a civil servant (*au*=.5), as figure 5.7 shows. Suppose that an individual enters the pension scheme at *age*. In this case, his or her current expected pension percentage is zero (he of she has not yet been contributing to the system), so the expected future pension is zero as well. In the next year, depending on the state β the individual is in (most likely the active state, of course), the expected old-age pension will have been increased by *au*[53]. However, it must be corrected for the possibility that the individual transits to one of the states which he or she is not in today. If he or she is currently active, he or she faces a certain probability Q_{exit} of transiting from one state to another, given the transition possibilities given in table 5.1. For instance, one could transit from the civil servant state to the disability state (DIS), the early retirement state (ERB) or the retainment pay state (RP25% and RP50%). In these cases, the value of *au* is adjusted. In general, for an individual of age *age* and an upbuilding *up* at *age*[54], if he or she remains in the state β, the expected future old-age pension for successive years is :

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[53] After, say, 6 years, the (expected) pension benefit will in the sixth year have increased with *au* times 1.75% times the discounted pension base PB. His or her total expected future pension benefit will then be (0 + 6 x *au*) times the discounted pension base PB.

[54] *Up* can be seen as the upbuilding of the individual in the current year that he or she is taken into consideration; if the individual is a new participant, *up* is clearly equal to zero).

$$E(OP)^{\beta}_{age} = 0 \times 0.0175 \times \frac{(Q_{\beta,D}(age,65))}{((1+r)^{65-age}} \times PB = 0$$

$$E(OP)^{\beta}_{age+1} = (Q_{\beta,exit}(age,age+1)) \times \frac{(au^{\beta} \times 1)}{(1+r)^{age+1-age}} \times 0.0175 \times \frac{(Q_{\beta,D}(age+1,65))}{(1+r)^{65-(age+1)}} \times PB \tag{A2.2}$$

$$E(OP)^{\beta}_{age+2} = \left[(Q_{\beta,exit}(age,age+1)) \times (Q_{\beta,exit}(age+1,age+2))\right] \times \frac{(au^{\beta} \times 2)}{(1+r)^{age+2-age}} \times 0.0175 \times \frac{(Q_{\beta,D}(age+2,65))}{(1+r)^{65-(age+2)}} \times PB$$

$$E(OP)^{\beta}_{age+3} = \ldots$$

The variable $Q_{\beta,D}$ denotes the probability that the individual does not die. The interpretation of $Q_{\beta,\ exit}(age,i)$ depends on the state β and therefore requires a more elaborate discussion. Remember that all individuals whose information is used to calculate the base-rate premium are (first-year) civil servants. So, the current state for all individuals is the state of being a civil servant. First of all, one can remain an active participant. In this case, $Q_{AC,\ exit}$ (age,i) is the probability that the individual transits from the state of being a civil servant to the same state, which is of course equal to one, times the probability that he or she remains in that state. But table 7.1 shows that there are five possible exit states: so, for β being other than the active state, $Q_{\beta,exit}(age,i)$ denotes the probability that the individual transits from the active state to state β and does not transit immediately away from that state. However, to keep the model as simple as possible, we ignore second-order transitions. For example, the model does consider the probability that an individual transits from the state of being a civil servant to, say, the state of being a non-contributing participant, but we do not consider the probability that an individual transits from being a civil servant to the state of being a non-contributing participant and subsequently back again to the state of being a civil servant[55]. The only exception to this rule is

[55] The reasons for this are numerous. First of all, given that an individual is currently an active participant, the only second-order transition which would in practice be possible is that one would first become a non-contributing participant and then a civil servant again. Other combinations are not, or are extremely remotely, possible. Secondly, the actual probability that an individual who was a non-contributing participant re-enters the state of being a civil servant, is unknown (at least, to me). Thirdly, the ABP does not seem to take this possibility into account as well, considering table 7.1. Thirdly, allowing for these second-order transitions would not only make the model much more complex (the total number of combinations would increase from $1+\beta$ to $1+\beta+\beta^2$.

the probability of death. Summarizing, $Q_{\beta,exit}$(age,i) for β being different than the state which the individual is in today, denotes the probability that the individual transits from the active state to state β and does not immediately decease in the new state.

So, the equation describing the expected value of the old-age pension of a new civil servant of *age* years old for the next year consists of two steps. First of all, the expected discounted value of the future pension benefit given the situation one year from now is found by multiplying the pension benefit which the individual gains between *age* and *age*+1 (being 1 times 0.0175*PB) with the probability that the individual lives up to the retirement age, and by discounting it back to *age*+1. Next, the resulting value is discounted further back from *age*+1 to *age*. Generally, for an individual in state β and of *age*, the expected old-age pension built up at *i-1>age* and i>age is:

$$\begin{aligned} E(op)_{i-1}^{\beta} &= Q_{\beta,exit}(age,i-1)\times\left(au^{\beta}\times(i-1-age)\right)\times 0.0175\times \\ &\quad \frac{Q_{\beta,D}(i-1,65)}{(1+r)^{(i-1)-age}(1+r)^{65-(i-1)}}\times PB \\ E(op)_{i}^{\beta} &= Q_{\beta,exit}(age,i)\times\left(au^{\beta}\times(i-age)\right)\times 0.0175\times \\ &\quad \frac{Q_{\beta,D}(i,65)}{(1+r)^{i-age}(1+r)^{65-i}}\times PB \end{aligned} \tag{A2.3}$$

For every future year i, an individual, however, runs a certain probability of ceasing to be in state β and therefore to swich in terms of 'pension regime' (that is, given the range of allowed transitions as presented in table 5.1: the actual probabilities are presented in the figures 5.8 to 5.12). Consequently, for every future year and for every possible pension regime, the expected discounted pension benefit for which one becomes eligible to over all future years, must be distinguished. In the case of the old-age pension, the extra expected old-age pension benefit for which one becomes eligible between *i*-1 and *i* can be written as the difference between $E(OP)_{i-1}^{\beta}$ and $E(OP)_{i}^{\beta}$:

$$\begin{aligned} OP^{\beta} &= \left[Q_{exit}(i-1,i)\times(i-age)-Q_{\beta,D}(i-1,i)\times(i-1-age)\right]\times \\ &\quad \frac{Q_{exit}(age,i-1)\times Q_{\beta,D}(i,65)\times au^{\beta}\times 0.0175\times PB}{(1+r)^{65-age}} \end{aligned} \tag{A2.4}$$

Combining equation A2.4 with equation A2.2 results in the formulation of the total expected old-age pension benefit for all future years and given n possible pension states β, as being:

$$\Sigma_{i=age}^{MIN(age+35,65)} \Sigma_{\beta=1}^{n+1} A^{\beta} \times B^{\beta}$$

$$where\ A^{\beta} = Q_{\beta,exit}(i-1,i) \times (i-age) - Q_{\beta,D}(i-1,i) \times (i-1-age) \qquad \textbf{(A2.5)}$$

$$where\ B^{\beta} = \frac{Q_{\beta,exit}(age,i-1) \times Q_{\beta,D}(i,65) \times au^{\beta} \times 0.0175 \times PB}{(1+r)^{65-age}}$$

First of all, in the above equation, n is the maximum number of states where the individual is allowed to transit to, as given in table 5.1. As all individuals taken into account are civil servants, table 5.1. shows that n equals 4. The aggregation from β=1 to β=n+1 simply means that the aggregation of the upbuilding of a (discounted future) pension claim must be made over all possible states to which the individual can transit (or remain in). Remember that $Q_{\beta exit}$ includes the probability of actually transiting to β: the aggregation over β, therefore, is an expected value calculation.

Secondly, note that the expected value of the annually gained extra pension benefit at the future age i is derived, given that one does not transit away from the state of being a civil servant between i and i-1. The reason is that, for every year, the 'new' expected discounted old-age pension benefit is expressed relative to the old-age pension benefit one year earlier. So, the probability that one ceases to be a civil servant between today's *age* and *i*-1 is already incorporated in the annual increase of the expected discounted old-age pension benefit between *i*-2 and *i*-1, and so forth down to *age*.

In the case of the built-in method, the actuarial formulae change somewhat. The built-in method implies that the total pension is derived without taking the AOW into account. Then the AOW benefit which the individual has built up[56] is subtracted from this total pension, resulting in the pension which the ABP has to provide. Analogous to equation A.2.1, define PB' to be:

$$PB' = \Sigma_{j=65}^{100}\left(\frac{(Q_{RET,D}(65,j)) \times (index)^{j-65}}{(1+r)^{j-65}} \times [(E(Wage(65))) - (age-15) \times 0.02 \times AOW]\right)$$

Note that the expected wage base at 65 (the variable E(WageBase(65))) which is the expected

[56] All individuals who lived in the Netherlands between the age of 15 and 65 receive a full (i.e. 100%) AOW benefit. Consequently, for every year that one has not been living in the Netherlands, one loses 2% of the future AOW benefit. Expressed in the terminology used in this study, we could say that the upbuilding rate of AOW is 0.02.

wage at 65 minus the franchise, is replaced by both the expected wage at 65 and the (expected) AOW-benefit. The expected future old-age pension built up in the current year now becomes:

$$E(OP)^{\beta}_{age} =$$

$$up \times 0.0175 \times \frac{Q_{\beta,D}(age,65)}{(1+r)^{65-age}} \times \Sigma_{j=65}^{100} \frac{Q_{RET,D}(65,j)}{(1+r)^{65-age}} \times E(Wage(65)) \qquad \textbf{(A2.6)}$$

$$-\ (age-15) \times 0.02 \times \Sigma_{j=65}^{100} \frac{Q_{RET,D}}{(1+r)^{j-65}} \times AOW$$

the general formulation for the future year that the individual reaches the age $i > age$, is:

$$E(OP)^{\beta}_{i} = Q_{\beta,D}(age,i) \times \frac{up + au^{\beta} \times (i-age)}{(1+r)^{i-age}} \times 0.0175 \times$$

$$\frac{Q_{\beta,D}(i,65)}{(1+r)^{65-i}} \times \Sigma_{j=65}^{100} \frac{Q_{RET,D}(65,j) \times index^{j-65} \times E(wage(65))}{(1+r)^{65-age}}$$

$$\textbf{(A2.7)}$$

$$-\ Q_{\beta,D}(age,i) \times \frac{(i-15)}{(1+r)^{i-age}} \times 0.02 \times \frac{Q_{\beta,D}(i,65)}{(1+r)^{65-i}} \times$$

$$\Sigma_{j=65}^{100} \frac{Q_{RET,D} \times index^{j-65} \times AOW}{(1+r)^{j-65}}$$

which can be simplified considerably to:

$$E(op)^{\beta}_{i} =$$

$$\left[0.0175 \times \left(up + au^{\beta} \times (i-age)\right) \times E(Wage(65)) - 0.02 \times (i-15) \times AOW\right] \qquad \textbf{(A2. 8)}$$

$$\times \frac{Q_{\beta,D}(age,65)}{(1+r)^{65-age}} \times \Sigma_{j=65}^{100} \frac{Q_{RET,D}(65,j) \times index^{j-65}}{(1+r)^{j-65}}$$

Following the same line of reasoning as before, this equation forms the basis for the annual upbuilding of the expected future discounted old-age pension OP. The explanation of the built-in method is the same in the case of the WW&O and disability pension benefit, so it will not be repeated in the next appendices.

Summarized, the total expected discounted value of the old-age pension benefit is the sum of the expected discounted values of the pension benefit which the individual can collect given the various states he or she can transit to, given the state which he or she is in today, at age *age*, and given the allowed transitions in table 5.1. In other words, the total OP is the sum of the state-specific values of OP.

Next, the state-specific formulation will be presented for the period from 1986 onward (i.e. under the assumption of an exemption method) up to 1995. For active particpants or civil servants, this is OP^{A}; for the disabled, it is OP^{DIS} whereas it is OP^{ERB}, OP^{NCP} and OP^{RET} for early retirement beneficiaries (including retainment pay beneficiaries, denoted by RP25% and RP50%), non contributing participants and retirees, respectively. Remember that the model is applied to first-year participants, so all individuals by definition are currently active. The formulations now to be presented should be compared to equation A2.4. Departing from this general formulation of OP^{β}, the specific pre-1995 formulation of the annual upbuilding of the expected discounted future old-age pension depends on which probability the individual faces to remain an active participant or not. Denote $P_{\alpha,\beta}(i)$ this annual probability of transiting from pension state α to pension-state β between the last day of the year i-1 and the last day of the year i. For each individual and each year between the age of entrance and 65 and given that he or she remains an active participant, his or her annual upbuilding OP^{A} is :

$$
\begin{gathered}
OP_i^A = \\
\left[Q_{\beta=A,exit}(i-1,i)\times(i-age)-Q_{A,D}(i-1,i)\times(i-1-age)\right]\times \\
\frac{Q_{\beta=A,exit}(age,i-1)\times Q_{A,D}(i,65)\times 1\times 0.0175\times Q_{A,D}(i,65)\times PB}{(1+r)^{65-i}}
\end{gathered}
\qquad \textbf{(A2.9)}
$$

$$
\begin{gathered}
where\ \ Q_{\beta=A,exit}(x,y|x<y)= \\
\left(1-P_{A,DIS}(x,y)-P_{A,NCP}(x,y)-P_{A,RP25\%}(x,y)-P_{A,RP50\%}(x,y)-P_{A,ERB}(x,y)\right)\times \\
(1-P_{A,D}(x,y))
\end{gathered}
$$

Formulated in words, this equation says that in any specific year in which the individual reaches age i as an active participant, he or she increases his or her discounted expected pension claim by one times 0.0175, and the probability that this happens is the compound probability that the individual remains active at the age of i, *given that he or she has been active up to i* (which means that he does not become disabled, or quits his job for another job, or enters an early retirement scheme), and that he or she does not die. This claim is then discounted by the discount rate of 4% and then corrected for the probability that the individual deceases between that specific future year (in which he or she reaches the age of i) and the age of 65.

However, not all individuals remain active until reaching the retirement age. In fact, any individual faces a certain probability of quitting the 'active' state and becoming either an early retirement beneficiary, a retainment pay beneficiary, a non-contributing participant (in which case *au* and consequently OP becomes zero) or a disability pension beneficiary. As the annual upbuilding of the expected future old-age pension will be discussed separately below, we concentrate on the annual upbuilding of the expected future old-age pension given that the individual who was active at *age* transits to either a early retirement benefit or a retainment pay benefit. The annual rate of upbuilding, if the individual does become a retainment pay beneficiary or an early retirement beneficiary, is half of the annual upbuilding of an active participant, and the discounted expected pension thus follows the same general form as presented above:

$$OP_i^{ERB \wedge RP25\% \wedge RP50\%} =$$

$$\begin{gathered}
[\ Q_{(\beta = erb \wedge rp25\% \wedge rp50\%),exit}(i-1,i) \times (i-age)\ - \\
(Q_{ERB,D}(i-1,i) + Q_{RP25\%}(i-1,i) + Q_{RP50\%}(i-1,i)) \times (i-1-age)\ ] \times \\
Q_{(\beta = erb \wedge rp25\% \wedge rp50\%),exit}(age,i-1) \times \\
(Q_{ERB,D}(i,65) + Q_{RP25\%}(i,65) + Q_{RP50\%}(i,65)) \times \\
\frac{\frac{1}{2} \times 0.0175 \times Q_{A,D}(i,65) \times PB}{(1+r)^{65-i}}
\end{gathered} \qquad \textbf{(A2.10)}$$

$$\begin{gathered}
\textit{where}\ Q_{(\beta = erb \wedge rp25\% \wedge rp50\%),exit}(x,y \mid x<y) = \\
\left[P_{A,ERB}(x,y) + P_{A,RP25\%}(x,y) + P_{A,RP50\%}(x,y)\right] \times \\
\left[P_{ERB,D}(x,y) + P_{RP25\%,D}(x,y) + P_{RP50\%,D}(x,y)\right]
\end{gathered}$$

This equation contains the compound probability that the individual enters an early retirement scheme or a retainment pay scheme at i, given that he or she has not done so before i. The second argument is the compound survival probability. Note that the pension base PB is not discounted by the compound probability that the individual deceases between i and 65. This is the result of the fact that the probability of decease is already included in $Q_{\beta,exit}$ as β differs from the current state of the individual (A).

Lastly, the annual increase of the expected discounted old-age pension benefit if an active participant today becomes disabled at the future age i, given that he or she did not do so before i, can be written as:

$$OP_i^{DIS} = A^{DIS} \times B^{DIS}$$

$$\text{where } A^{DIS} = \left[Q_{A,DIS}(i-1,i)\times(i-age) - Q_{DIS,D}(i-1,i)\times(i-1-age)\right] \qquad \textbf{(A2.11)}$$

$$\text{where } B^{DIS} = \frac{Q_{A,DIS}(age,i)\times Q_{DIS,D}(i,65)\times(.87\wedge.91)\times 0.0175\times Q_{A,D}(i,65)\times PB}{(1+r)^{65-i}}$$

It is important to see that this OP^{DIS} does not enter equation 7.2 separately: instead, it forms a part of the total pension benefit of disabled, IP^{DIS}. This will be discussed later in this appendix.

The above equations OP^{A}, $OP^{ERB\wedge RP}$ and OP^{DIS} were all under the assumption that the individual is a first-year participant, which implies that he or she is by definition an active participant at *age* and that *up* is equal to zero. In the actuarial model after 1995, the information which is used is no longer restricted to new participants: the assumption that today's upbuilding percentage *up* equals zero does not therefore hold any longer and neither does the assuption that the individual is an active participant at *age*. This causes a notational difference: before 1995, the 'departure state' was the same for all actuarially-relevant individuals in the sense that they were by definition all civil servants. Here, it is no longer the case, so the departure state must be included in the notation. This is done by adding $|\beta$ to the superscript of the equations. So, $OP^{\alpha|\beta}$ denotes the annually gathered extra pension benefit, given the probability that someone who is in pension-state α today, at age, will be in pension-state β at the future age i. In this case, departing from the general formulation given earlier, the specific formulation of the annual increase of the expected discounted future old-age pension benefit, $OP^{A|A}_i$ is not enough, since this is entirely based on future upbuilding and therefore ignores the upbuilding done in the past (and presented by *up*). So, for any current state and possible future pension-state, the total discounted old-age pension benefit is no longer equal to the sum of OP for future years, as was the case in equation A2.2. Instead, the total discounted expected old-age pension benefit is the sum of these values of OP, the old age pension to be formed in the future, and the discounted expected old-age pension benefit based on the past upbuilding *up*. Formally, this becomes:

$$N_{age}^{op,\beta|A} = \left[\frac{up \times 0.0175 \times Q_{death}^{|A}(age,MIN(age+35,65))}{(1+r)^{65-age}}\right] \times PB + \Sigma_{i=age}^{MIN(age+35,65)} \left[OP_i^{A|A} + OP_i^{DIS|A} + OP_i^{ERB\wedge RP|A}\right] \quad \textbf{(A2.12)}$$

The variable $Q_{death}^{|A}(age,MIN(age+35,65))$ denotes the total compound probability that the individual lives up to the retirement age (or the actuarial horizon of 35 years) in one of the possible pension-states, given the state as civil servant which he or she occupies at *age* and following the transition possibilities as described in table 5.1. This compound probability can be written out as:

$$\begin{aligned} Q_{death}^{|A}(age,MIN(age+35,65)) = \\ \Sigma_{i=age}^{MIN(age+35,65)} Q_{A,D}(age,i) \times (Q_{A,I}(age,i)) \times Q_{I,D}(i,MIN(age+35,65)) + \\ Q_{A,D}(age,i) \times (Q_{A,RP\wedge ERB}(age,i)) \times Q_{RP\wedge ERB,D}(i,MIN(age+35,65)) + \\ Q_{A,D}(age,i) \times (Q_{A,NCP}(age,i)) \times Q_{NCP,D}(i,MIN(age+35,65)) \end{aligned} \quad \textbf{(A2.13)}$$

Apart from a notational difference (OP^A becomes $OP^{A|A}$), the actual description of $OP^{A|A}$ remains the same as in the pre-1995 situation (as it reflects the future pension claim) and as described in equation A2.9, so it will not be repeated here. The same goes for $OP^{ERB\wedge RP|A}$ and $OP^{DIS|A}$ which are described in equations A2.10 and A2.11.

The main difference with the pre-1995 situation is the fact that up_t is no longer by definition equal to zero, since individuals who are not first-year participants and therefore already have an upbuilding from past contributions which has to be taken into account. This *up* enters the formulation of N_{age} separately from OP_{age}, the annual increase of the expected value of the future pension benefit. The actuarially-expected discounted expected future old-age pension benefit is therefore described by one equation (A2.12) consisting of two parts, of which the annual extra pension benefit OP^{β} is one part. Note finally that only the expected future old-age pension benefit for somebody who is an active participant today (reflected by the letter 'A' right of the vertical line in the superscipt), and given the probability that one remains an active participant in the future (as shown by the letter 'A' left of the vertical line), has been written out in full in the above equation. The reason is that the model does not take into account the possibility that somebody who is a non-active participant in the pension fund (for instance, a disabled or an early retirement beneficiary) becomes a civil servant and therefore an active participant again. This can be seen in table 5.1. In other words, $OP^{A|DIS}$, $OP^{A|ERB\&RP}$ and so forth, simply do not exist.

A second important difference with the pre-1995 model is that the set individuals whose information is used as input in the actuarial model is extended from active participants to include other categories of individuals in the pension fund as well. First of all, based on table 5.1, the number of possible exit states if one is disabled is not as great as if one were an active participant. In fact, it is assumed that whoever is disabled, remains disabled. Likewise, early-retirement beneficiaries cannot transit to another state[57]. This is a common assumption for all actuarial equations describing other than active participants. If our individual were to become disabled, an early retirement beneficiary, a WW&O-pension beneficiary or an old-age pension beneficiary, the only state to move to from there would be death, as table 5.1 shows. Using this information, equation A2.3 can be rewritten, resulting in a considerable simplification of equations A2.4 and A2.5. Suppose again that our individual is in state β where $\beta \neq AC$. Equation A2.3 becomes:

$$\begin{aligned} E(OP)_{i-1}^{\beta \neq ac} &= Q_{\beta,D}(age,i-1) \times \left(au^{\beta} \times (i-1-age)\right) \\ &\times 0.0175 \times \frac{Q_{\beta,D}(i-1,65)}{(1+r)^{(i-1)-age}(1+r)^{65-(i-1)}} \times PB \\ E(OP)_{i}^{\beta \neq ac} &= Q_{\beta,D}(age,i) \times \left(au^{\beta} \times (i-age)\right) \times \\ &0.0175 \times \frac{Q_{\beta,D}(i,65)}{(1+r)^{i-age}(1+r)^{65-i}} \times PB \end{aligned} \qquad \textbf{(A2.14)}$$

Again, the first difference results in the equivalent of equation A2.4:

[57] With respect to their future old-age pension benefit, that is. The actuarial information concerning the WW&O-pension claim will be discussed later.

$$OP^{\beta \neq ac} = \left[\frac{Q_{\beta,D}(age,65) \times au^{\beta} \times 0.0175 \times PB}{(1+r)^{65-age}} \right] \tag{A2.15}$$

Remember, though, that the above formula is a special case of equation A2.3 and A2.4.

Now let us define the state-specific formulations of the expected discounted old-age pension benefit for individuals who are currently other than active. The point of departure again is equation A2.12, with the difference that the extension $|A$ is replaced by $|\beta$. As this is the only difference, this equation will not be repeated here. Instead of $OP^{A|A}$, for instance, the second part of equation A2.12 consists of $OP^{DIS,DIS}$, $OP^{ERB|ERB}$, $OP^{NCP|NCP}$ and $OP^{RET|RET}$, which will be formulated now. The derivation of these variables is made using the fact that the only exit state is death, which results in a considerably more simple formulation, as shown in equation A2.15. The first of these can be written as:

$$OP_{age}^{DIS|DIS} = \Sigma_{i=age}^{MIN(age+35,65)} \frac{Q_{DIS,D}(age,65) \times (.87 \Lambda .91) \times 0.0175}{(1+r)^{65-age}} \times PB \tag{A2.16}$$

The same holds for $OP^{ERB|ERB}$, in the below equation A2.17:

$$OP_{age}^{ERB \Lambda RP|ERB \Lambda RP} = \Sigma_{i=age}^{MIN(age+35,65)} \frac{Q_{ERB \Lambda RP,D}(age,65) \times \frac{1}{2} \times 0.0175}{(1+r)^{65-age}} \times PB \tag{A2.17}$$

As was the case before 1995, the annual increase of non-contributing participants ($OP^{NCP|NCP}$) is by definition equal to zero. This means that the future pension benefit of current non-contributing participants is fully described by past information (apart from the simple death probability, of course). This can be written as:

$$N^{NCP|NCP} = up \times 0.0175 \times \frac{Q_{NCP,D}(age,65)}{(1+r)^{65-age}} \times PB \tag{A2.18}$$

and the (fictitious) annual upbuilding $OP^{NCP|NCP}$ of non-contributing participants is therefore zero.

The only category which has not been discussed is the group of those actually receiving an old-age pension. Apart from the fact that the total upbuilding does not change anymore, as is the case with non-contributing participants, the first main difference between the pension claim of retired participants and active participants lies in the pension base *PB*, as this is no longer the sum of discounted pensions from the retirement age onward, but only from the current *age* of the participant onward.

$$PB^{RET} = \Sigma_{j=age}^{100} \frac{((Q_{RET,D}(65,j)) \times (index)^{j-65} \times (E(WageBase(65))))}{(1+r)^{j-age}} \tag{A2.19}$$

The fact that *up* does not change anymore for old-age pension beneficiaries, as was the case for non-contributing participants, implies that $OP^{RET|RET}$ is zero. The future pension benefit for current retirees of *age*>65 can be written as:

$$N_{age}^{RET|RET} = up \times 0.0175 \times PB_{age}^{RET} \tag{A2.20}$$

Appendix 2.2: Disability Pension and Early Retirement benefit.

In the actuarial model before 1995, the discounted expected future disability pension as well as the discounted expected future early retirement benefit are taken into account. In the actuarial model after 1995, this is no longer the case. As a consequence, this second appendix is only relevant for the pre-1995 situation. The formulation of the discounted expected future disability and early retirement benefits is quite similar and consists of two parts. If one becomes disabled or an early retirement beneficiary, first of all, one receives a disability pension or an early retirement benefit, respectively. This benefit is a certain fraction of the final wage. Secondly, one builds up a future old-age pension while being disabled, though at a different rate to active participants. The (future) disability pension of an individual becoming disabled at the future age i, is:

$$DIP_i = \Sigma_{j=i}^{64} \frac{A(gender) \times Q_{I,D}(i,j) \times E(WageBase(i))}{(1+r)^{j-i}} \qquad \textbf{(A2.21)}$$

Note that $WageBase_I$ is not the same as *WageBase* as introduced earlier. The difference is that the wage is corrected for the General Disablement Benefits Act (AAW-Algemene ArbeidsongeschiktheidsWet) instead of the General Old Age Act (AOW). *A(gender)* denotes the fraction which represents the average disability pension, as a fraction of the wage. We know from the discussion of figure 7.7 that *A(gender)* is on average 0.61 for men and 0.63 for women[58]. The above formulation clearly shows that the disability pension is a certain fraction (reflected by *A(gender)*) of the final wage of the individual. When an individual becomes eligible for a disability pension at age *i*, the upbuilding for a future old-age pension continues, though at a rate *au* different from 1. The average annual rate of upbuilding *au* depends on gender as well: this is reflected by au which is 0.87 for men and 0.91 for women[59]. For a disabled individual, the upbuilding of the future old-age pension continues, as described by $OP^{DIS|DIS}_i$, presented in appendix 2.1 equation A2.16

As we did in the case of the expected discounted future old-age pension benefit ($OP^{DIS|DIS}$), we must now rewrite DIP to the extra (discounted and expected) disability pension benefit which one receives when one does not become disabled at *i*, but at *i*+1 instead. Here, the difference between DIP_{i+1} and DIP_i can be written as:

[58] Again, this is a simplification of the real situation: for a fully disabled individual, the disability pension benefit is 70% of the final wage minus the exemption, augmented with 2 times 3%. However, as not every disabled individual is completely (100%) disabled, the average benefit is lower than that.

[59] Again, the (quite complex) process of how the exact individual disability benefits and annual upbuilding rates are determined, is avoided by simply taking a pension-fund wide average, specified to gender, for both the benefit and the annual rate of upbuilding, which is then considered to be exogenous (apart from gender, of course) and fixed.

$$DIP_{i+1} - DIP_i =$$

$$\Sigma_{j=i+1}^{64} \frac{A(gender) \times Q_{I,D}(i+1,j) \times E(WageBase(i))}{(1+r)^{j-i-1}} -$$

$$\Sigma_{j=i}^{64} \frac{A(gender) \times Q_{I,D}(i,j) \times E(WageBase(i))}{(1+r)^{j-i}} = \qquad \textbf{(A2.22)}$$

$$- \Sigma_{j=i}^{i+1} \frac{A(gender) \times Q_{I,D}(i,j) \times E(WageBase(i))}{(1+r)^{j-i}} =$$

$$- \frac{A(gender) \times Q_{I,D}(i,j) \times E(WageBase(i))}{(1+r)}$$

Consequently, the annual extra disability pension is negative. The annual extra disability pension and (discounted expected future) old age pension can be written as:

$$IP_i = P_{A,I}(i-1,i) \times Q_{I,D}(i-1,i) \times$$

$$\left[- \frac{A(gender) \times Q_{I,D}(i,i+1) \times E(WageBase(i))}{1+r} + OP_i^{dis} \right] \qquad \textbf{(A2.23)}$$

Of course, the fact that the annual extra disability pension is negative is not very unexpected: unlike the old-age pension, the level of the disability pension benefit is independent on the age at which the individual becomes disabled. So, if an individual becomes disabled one year later than another individual with exactly the same characteristics, he or she receives the same disability-pension benefit, but only for a one-year shorter period of time. However, the fact that the extra disability pension which an individual 'collects' in one year is negative, is not enough for the determination of the expected value of the total disability pension benefit, since a 'starting point' is required in order to prevent us from ending up with a negative expected value of the disability pension benefit. As the total discounted disability pension benefit is independent of the age *i* in which one becomes disabled, this starting point is the highest value of the discounted disability pension benefit, and this is clearly the total discounted disability pension benefit if one becomes disabled today (at *age*) instead of in the future (at age *i*). So, if IP is the annually-gathered extra total pension benefit (including old-age pension benefit), the total discounted expected (disability- and old-age) pension benefit becomes:

$$total\ IP = \Sigma_{i=age+1}^{64}\left[IP_i + \frac{A(gender)\times Q_{I,D}(age,i)\times E(WageBase(age))}{(1+r)^{65-age}}\right] \tag{A2.24}$$

In the case of the early retirement benefit, the same line of reasoning holds. The relevant equations become:

$$DERB_i = \Sigma_{j=i}^{64}\frac{erbpct\times Q_{ERB,D}(i,j)\times E(Wage(i))}{(1+r)^{j-i}} \tag{A2.25}$$

and

$$\begin{gathered} ERB_i = P_{A,ERB}(i-1,i)\times Q_{ERB,D}(i-1,i)\times \\ \left[-\frac{erbpct\times Q_{ERB,D}(i,i+1)\times E(Wage(i))}{1+r} + OP_i^{erb}\right] \end{gathered} \tag{A2.26}$$

of which the first part between brackets is again negative. Finally, the 'total ERB' is:

$$\begin{gathered} total\ ERB = \\ \Sigma_{i=age+1}^{64}\left[ERB_i + \frac{erbpct\times Q_{ERB,D}(age,i)\times E(Wage(age)}{(1+r)^{j-i}}\right] \end{gathered} \tag{A2.27}$$

In the above equations describing the expected future pension benefit if one becomes an early retirement beneficiary, the variable *erbpct* denotes the early retirement benefit, as a percentage of the final wage. Before 1993, this was 80%, after that year, it decreased to 75%. Again, after 1995, if the individual is already an early retirement beneficiary, the $ERB^{|ERB}$ is found by setting $P_{A,ERB}(i-1,i)$ equal to 1.

Appendix 2.3: Widows/Widowers- and Orphans pension.

The differences between the WW&O-pension scheme and the other pension schemes are discussed in the main text, so they will be repeated only very briefly here. First of all, the the receiver or beneficiary (the surviving partner) is not the same as the claimant (who was participating in the pension scheme and who died). Secondly, only if the claimant dies while being a civil servant, the number of upbuilding years is adjusted to reflect the fictitious situation where the individual would have remained being an active participant up to the retirement age.

Moreover, apart from this difference, which depends on the situation of the deceased beneficiary, the actual WW&O-pension benefit depends also on the characteristics of the beneficiary. If the surviving partner is younger than 65, the benefit (five-seventh times the fictitious old-age pension) is increased by 1.129 times 1.6, as said earlier in paragraph 7.1.

For active claimants, the probability that the beneficiary receives such a benefit between age a and b can be written as:

$$\begin{aligned} PROB_{a,b}^{A} = \\ \Pi_{k=a}^{b}\Big(&\left[1-P_{A,DIS}(k)-P_{A,NCP}(k)-P_{A,RP25\%}(k)-P_{A,RP50\%}(k)-P_{A,ERB}(k)\right]\times P_{A,D}(k) \\ &+\left[P_{A,NCP}(k)+P_{A,RP25\%}(k)+P_{A,RP50\%}(k)+P_{A,ERB}(k)\right]\times P_{NCP,D}(k) \\ &\times P_{A,M}(k)\times(1-P_{partner,D}(k)) \\ &+\left[P_{A,DIS}(k)\times P_{DIS,D}(k)\times P_{DIS,M}(k)\right]\times(1-P_{partner,D}(k))\Big) \end{aligned} \qquad \textbf{(A2.28)}$$

If the participant is in either of the other categories, $PROB^{\beta\neq A}$ is:

$$PROB_{a,b}^{\beta} = \Pi_{k=a}^{b}\left[P_{\beta,D}(k)\times P_{\beta,M}(k)\times(1-P_{partner,D}(k))\right] \qquad \textbf{(A2.29)}$$

where β again denotes the state of the individual (retired, early retirement beneficiary, disability, non-contributing participant). $P_{\beta,D}$ and $P_{\beta,M}$ denote the probability of decease, or being married, given the state one is in. Note that the latter equation is simpler than the former, due to the fact that the possibility of re-entering the state of being a civil servant is not taken into account, for reasons explained before. Lastly, before turning to the actuarial modelling of the WW&O-pension benefit, let us dwell briefly on the death probability of the partner or beneficiary. The problem is that we do not have any information on the partner, apart from the fact that he or she is of the opposite sex to the claimant. The actuarial employees of the ABP have overcome this problem by making some assumptions, which I follow: first, that the partner or beneficiary is assumed to be three years younger than the claimant. Secondly, if the partner is younger than 65, his or her probability of decease is assumed to correspond to those of civil servants. If the partner is 65 or older, the probability of decease of old-age pension beneficiaries is used. Formally: $P_{partner,D}=P_{A,D}$ if $(age\text{-}3<65)$ and $P_{partner,D}=P_{RET,D}$ if $(age\text{-}3\geq 65)$.

Knowing the probability that the partner of a claimant actually does become eligible for a WW&O pension, the explanation of how the WW&O pension is derived, is provided for various categories of participants. Each category contains one or more groups (active, disabled and so forth). First of all, a distinction must be made between participants younger and older than the retirement age. The latter category contains only the group of retirees. The former category must be subdivided into, firstly, active participants (whose annual rate of upbuilding *au* is equal to 1). The second category consists of participants whose annual rate of upbuilding *au* is not equal to one or zero. This category consists of disabled, early-retirement beneficiaries, retainment-pay beneficiaries. The last category are those individuals younger than the retirement age, whose annual rate of upbuilding *au* is zero. This category contains only one group: the non-contributing participants.

Thus, two main categories must be considered. The first is that the claimant (who participated in the pension scheme and whose surviving partner is eligible for the WW&O pension) is younger than 65 in the year of death. The second case is that the claimant is 65 or older in the year of death. To simplify considerably, two assumptions are introduced: first of all, let us assume that the surviving partner or beneficiary who is age_w years old, reaches the age of age^{max}. Generally, as is explained in the main text, this age^{max} is set equal to 100[60]. So, before that age, the probability of death of the partner is 0 and at age^{max}, this probability is 1. This -as will be shown- is not the case for the beneficiary himself; the probability that a partner becomes a widow or widower of the beneficiary, is equal to PROB.

Let us start with the first case: the point of departure is the discounted WW&O pension at time i for each upbuilding year, which is described in equation A2.30:

$$DISC_i = \frac{1}{(1+r)^{i-age}} \times \left((E(WageBase(i))) \times (1.129) \times (1.6) \times \Sigma_{j=i-3,\, i-3<64}^{64} \frac{Q_{A,D}(i-3,j)}{(1+r)^{j-(i-3)}} \times (index)^{j-(i-3)} \right. + \frac{1}{(1+r)^{i-age}} \times \left. \left(\frac{(E(WageBase(i)))}{(1+r)^{65-(i-3)}} \times \Sigma_{j=i-3,\, i-3\geq 65}^{100} \frac{Q_{P,D}(i-3,j)}{(1+r)^{j-(i-3)}} \times (index)^{j-(i-3)} \right) \right) \qquad \textbf{(A2. 30)}$$

This DISC basically has the same function as DIP in the case of the disability pension benefit and PB in the case of the old age pension benefit: the benefit which should be paid out is a certain fraction of this value. Its discussion should sound familiar by now: if the partner of the deceased individual (the beneficiary) is 65 or older, the first half of the equation (the second line)

[60] It should be noted that the various transition probabilities for ages over 65 mostly go up to 105. However, as the 'risk-set' of these transitions. (the number of individuals in the set of which a certain fraction actually transits) is extremely low for ages over 100, these transition probabilities are highly unreliable.

naturally becomes zero: as a consequence, DISC strongly resembles PB as discussed earlier. It is the discounted wage-base (i.e. the wage minus the franchise) totalled over all future years, while taking the survival probability of the partner into account. If the partner is younger than the retirement age, however, he or she becomes entitled to a pension benefit until he or she reaches the retirement age as well. So, in this case, he or she is eligible to a fraction of the wage base times 1.129 times 1.6 (the average orphans' benefit) and -again- discounted corrected for the survival probability of the partner. For all the years after retirement age, the pension base is as already discussed.

This value of $DISC_i$ must then be multiplied by the total upbuilding at time i. If a claimant dies at $age < 65$, while being a civil servant, the benefit is adjusted as if the deceased would have been working up to the retirement age. In this case, in the actuarial model from 1995 onwards, the beneficiary receives:

$$(up + 65 - age) \times 0.0175 \times \frac{5}{7} \times DISC_i \qquad \textbf{(A2.31)}$$

In the actuarial model before 1995, the equation stays the same, but with up=0. If the deceased claimant was younger than 65 but not an active participant, the upbuilding percentage up is not adjusted. We will first deal with the case that one is younger than the retirement age. As it is an important and specific case, we will also assume that the individual is a civil servant. Later, we will look at the discounted expected widows- and widowers pension benefit of individuals older than the retirement age.

Let us take the category of participants who are younger than the retirement age and who are active participants (au=1) as a point of departure. Moreover, for a good understanding of what is happening, let us return to the basis. The question which must be answered, is "what is the expected value of the current and future WW&O pension for an active individual claimant of age age?". This expected value can be written as:

$$E(WW\&O)^{A|A} = PROB^{A}_{age,age}\times(up+65-age)\times0.0175\times\frac{5}{7}\times DISC_{age} +$$

$$PROB^{A}_{age,age+1}\times(up+1+65-(age+1)))\times0.0175\times\frac{5}{7}\times DISC_{age+1}$$

$$+\ldots+$$

$$PROB^{A}_{age,65}\times(up+(65-age)+0)\times0.0175\times\frac{5}{7}\times DISC_{65}$$

However, the probability that an individual who is *age* years old, does not survive up to *age*, is zero (see footnote 59). So $PROB^{A}_{age,age}=0$ which means that the first term of the above summation becomes zero. Using this, the general form of the above summation becomes:

$$E(WW\&O_{age})^{A|A} = \Sigma^{65}_{i=age+1} PROB^{A}_{i-1,i}\times(up+(i-age)+(65-i))\times0.0175\times\frac{5}{7}\times DISC_{i}$$

$$\Leftrightarrow E(WW\&O_{age})^{A|A} = \Sigma^{65}_{i=age+1} PROB^{A}_{i-1,i}\times(up+65-age)\times0.0175\times\frac{5}{7}\times DISC_{i} \qquad \textbf{(A2.32)}$$

The first line of this equation shows the modification of the upbuilding. Departing from today's upbuilding *up*, which is given, the upbuilding increases by one for every future year. However, in the same time, the adjustment of the upbuilding if the individual deceases decreases by one, since the number of years which the individual would have to cover to reach the retirement age decreases by one. On the whole, these two adjustments cancel each other out, thereby making the actual upbuilding independent of when in the future the event of decease will actually take place.

As we did in the case of the old age pension benefit and the disability pension benefit, the future annual upbuilding NP, is defined as the argument of the aggregation over all future years until 65:

$$E(WW\&O_{age})^{A|A} = \Sigma^{65}_{i=age+1} NP^{A|A}_{i}$$

$$NP^{A|A}_{i} = PROB^{A}_{i-1,i}\times(up+65-age)\times0.0175\times\frac{5}{7}\times DISC_{i} \qquad \textbf{(A2.33)}$$

Note again that the partner (the future beneficiary) is assumed to be three years younger than the active participant in the fund, who is the claimer of the (future) WW&O pension. Thus, the value of DISC is based on the characteristics of the claimant (of age *i*-3), whereas the probability that the claimant will one day actually receive a pension, *PROB*, depends on the characteristics of the beneficiary. In other words, its value is based on *i*.

Up to now, the annual upbuilding of the WW&O pension of the active group of participants has been derived, on the assumption that they remain active participants. In this case, the WW&O pension is adjusted as if the deceased individual would have continued working until retirement age. The other possibilities are, first of all, that one is not in the active state and remains in that inactive state and, secondly, that one is in the active state and transits to an inactive state. Writing out the formulations of NP given that a claimant remains in the state (other than the active state) which one is at *age*, will be presented first. The equations of NP given that one transits from the active state to any other (according to table 5.1, relevant) state, will be presented briefly (since it does not add much to the understanding of the model) at the end of this appendix. First, as its formulations are closer to the ones we have just discussed, let us consider the actuarial equations describing the WW&O-pension benefit of individuals who are not in the active state and who are assumed to remain in that state.

In the case of the WW&O pension of groups of participants who died while being active participants in the fund, adjustment of the total upbuilding as if the individual had remained working up to the retirement age is not made. Those individuals who are not in the active state and remain in that state can in turn be subdivided in three groups. First of all, we have those individuals who are younger than the retirement age, and whose annual upbuilding *au* is not equal to 1, but not equal to zero, either. These are the disabled, the early retirement beneficiaries and the retainment pay beneficiaries. In this case, the expected future annual upbuilding can be derived as follows:

$$
\begin{aligned}
&E(WW\&O_{age})^{\beta|\beta} = \\
&\Sigma_{i=age+1}^{65} PROB_{i-1,i}^{\beta}\times(up+(i-age)\times au^{\beta})\times 0.0175\times\frac{5}{7}\times DISC_i \\
&\rightarrow NP^{\beta|\beta} = PROB_{i-1,i}^{\beta}\times(up+(i-age)\times au^{\beta})\times 0.0175\times\frac{5}{7}\times DISC_i
\end{aligned}
\qquad \textbf{(A2.34)}
$$

As opposed to OP in the appendix 2.1, the upbuilding which the individual has at *age*, *up*, does enter the NP. This is because it does not change anymore (and the transitivity rule therefore can be used), whereas other variables change. Note furthermore that the total upbuilding is no longer adjusted as if the individual would have remained a civil servant up to reaching the retirement age.

Next, we have those individuals who are younger than the retirement age, but who do not have any annual upbuilding, and who have not reached the retirement age. This category contains only the the non-contributing participants. In this case, *au* equals zero.

$$E(WW\&O_{age})^{NCP|NCP} = \Sigma_{i=age+1}^{65} PROB_{i-1,i}^{NCP} \times up \times 0.0175 \times \frac{5}{7} \times DISC_i$$

$$\leftrightarrow NP^{NCP|NCP} = PROB_{i-1,i}^{NCP} \times up \times 0.0175 \times \frac{5}{7} \times DISC_i \tag{A2.35}$$

The third subgroup of individuals who are not in the active state and who remain in their state and who have not sofar been discussed, is the group of old-age pension beneficiaries, those who are older than 65, and the group of individuals who actually receive a WW&O-pension benefit. Let us start with the retirees. As was the case with the group of non-contributing participants, there is no annual upbuilding, since *au* is -of course- equal to zero. However, there are some differences with the groups of participants discussed sofar, which makes the group of retirees a very distinct group as far as the derivation of the WW&O pension is concerned. The first difference is that $DISC_i$ is no longer based on Ewage(age), but on Ewage(65). Note that the fact that the structure of $DISC_i$ does not change for the restriction that the beneficiary is 65 or older does not automatically imply that the claimaint (who is assumed to be three years younger) is 65 or older. In this case, if an individual dies at $age > 65$, the widow of the beneficiary receives:

$$\Sigma_{i=age_w+1}^{100} up \times 0.0175 \times \frac{5}{7} \times DISC_i \times PROB_{age_w,i} \tag{A2.36}$$

and following the same line of reasoning as presented above, the annual upbuilding NP_i now becomes:

$$NP_i^{RET|RET} = up \times 0.0175 \times \frac{5}{7} \times DISC_i \times PROB_{i-1,i}^{RET} \tag{A2.37}$$

Next, we turn to the group of individuals who actually receive a WW&O-pension benefit. In this case, the formulation of NP does have in common with equation A2.35 describing $NP^{RET|RET}$ that the upbuilding is no longer altered. However, the difference is that the probability that one becomes eligible to a WW&O-pension benefit given the pension state one is in, PROB, becomes irrelevant, because these individuals already receive such a benefit. Instead, it is replaced with a simple survival probability:

$$NP_{age<65}^{WW\&O|WW\&O} = up \times 0.0175 \times \frac{5}{7} \times DISC_i \times Q_{A,D}(i-1,i)$$

$$NP_{age\geq 65}^{WW\&O|WW\&O} = up \times 0.0175 \times \frac{5}{7} \times DISC_i \times Q_{RET,D}(i-1,i) \qquad \textbf{(A2.38)}$$

Now we have discussed the actuarial WW&O-pension claim of active participants who remain active and of participants who are not active (i.e. not civil servants) and who remain in that state. Last but not least, let us consider those individuals who are civil servants, but do not remain in that state. These formulations for the actuarial WW&O-claim taking into account the fact that one ceases to be a civil servant and transits to another state, are easily derived using equation A2.29 and taking into account that the total upbuilding is not adjusted as if the deceased were to have continued working until retirement age. The annual increase of the WW&O pension benefit if one transits to state β is:

$$NP_i^{\beta|A} = P_{A,\beta}(i) \times NP_i^{\beta|\beta}$$

$$\Leftrightarrow NP_i^{\beta|A} = P_{A,\beta}(i) \times PROB_i^{\beta} \times (up + (i-age) \times au^{\beta}) \times 0.0175 \times \frac{5}{7} \times DISC_i \qquad \textbf{(A2.39)}$$

So, as an example, $N^{PERB\wedge RP}_{i}$ can be written as:

$$NP_i^{ERB\wedge RP|A} = P_{A,ERB\wedge RP}(i) \times PROB_i^{ERB\wedge RP} \times \left(up + (i-age) \times \frac{1}{2} \right) \times 0.0175 \times \frac{5}{7} \times DISC \qquad \textbf{(A2.40)}$$

The value of NP in the event that an individual who is an active participant becomes disabled can be derived by replacing the upbuilding rate ½ by 0.87 or 0.91 and by changing the transition probabilities -depending on the gender of the individual - in this equation A2.39. As a second typical example, the value of NP for non-contributing participants who are currently active participants can be written as:

$$NP_i^{NCP|A} = P_{A,NCP}(i) \times PROB_i^{NCP} \times up \times 0.0175 \times \frac{5}{7} \times DISC_i \qquad \textbf{(A2.41)}$$

Note, by the way, that $NP^{RET|A}$ is a meaningless number-even though it is formally perfectly derivable- since the probability that one retires between age and 64 is zero (of course, one can retire earlier than the retirement age, but that would imply a transition to the early retirement state ERB and not the retirement state RET).

Appendix 3: Why was the upbuilding percentage not adjusted simultaneously with the transition from a final wage scheme to an average wage scheme?

It was argued in chapter six that the transition from a final wage scheme to an average wage scheme can have an important effect on the (lifetime) pension benefit which participants receive. This is why it is sometimes argued that such a transition should be accompanied by an increase in the speed of upbuilding. This way, the decrease in the pension base could be neutralized by the higher upbuilding. For each year that a civil servant contributes to the pension fund, his or her expected pension benefit increases by 1 times 0.0175. So, why did we not do so? In this appendix, some consequences of such an increase in upbuilding will be explained. It will be argued that for technical reasons, such an increase is not possible in the context of this model, at least not without not only having to make unrealistic assumptions, but also without causing large disturbing redistributions.

In theory, such an adjustment of the upbuilding rate 0.0175 can be done very easily. Suppose an individual of age a in the year that the pension fund replaces the final wage FW by the average wage AW as the basis for the future pension benefit. Suppose, furthermore, that this individual entered the fund at the age of 25. If we ignore discounting for a moment, then the expected future pension claim gathered at the age a is $(a\text{-}25)\times 0.0175\times FW$. With the adjustment α, the future expected pension benefit, to be gathered from this year on, is $(65\text{-}a)\times 0.0175\times\alpha\times AW$. We want α to be set so as to compensate for the transition from FW to AW. The total expected future pension benefit, given α, therefore should be equal to the expected future pension benefit if the transition did not occur, which is $40\times 0.0175\times FW$. So, we have $(a\text{-}25)\times 0.0175\times FW + (65\text{-}a)\times 0.0175\times\alpha\times AW = 40\times 0.0175\times FW$. From this follows that $\alpha=FW/AW$. In words, this means that the adjustment of the upbuilding rate is independent of the age-distribution of the participants in the pension fund. One uniform adjustment can be calculated and applied to all individuals.

If this adjustment is age-independent and very simple to calculate, why wasn't it implemented? Because the model used in this study is more complicated than the simple, theoretical model we just have described.

First of all, the model keeps track of the past upbuilding years of the individual, but not directly of the past upbuilding fraction, which is the past upbuilding times the upbuilding rate. If the upbuilding rate were to be changed, then not only the future upbuilding would change with

α, but the past upbuilding as well. This problem could be solved by dividing the past upbuilding by α in the year of the transition. However, the pension fund model as described in the main text, does not only consist of an actuarial module, where the expected future pension claim is derived and which forms the basis of the endogenous contribution rate. There is an actual model as well, where the pension fund state of the individual is determined and where the actual pension benefit (if necessary) is calculated. An adjustment of the upbuilding rate with a would have profound consequences in this part of the pension-fund model. If we were simultaneously to multiply the upbuilding rate by α and divide the past total upbuilding by α, then this would have profound effects on the 'actual' side of the model. For instance, if one individual were to become disabled one year after this transition, his upbuilding would become (a-25)*0.0175/α + 1×0.0175×a, which means that the actual benefit would decrease, a decrease which would be considerably greater than the gradual decrease which would be the result of the change of the wage-base.

The second reason is that the adjustment of the upbuilding rate may be convenient in the case of an old-age pension, but it is less simple in the case of the WW&O-pension benefit. For, contrary to the old-age pension benefit, the expected WW&O-pension is not based on the final wage or the average-wage at 65, but on today's final or average wage. In the above stylized example, the strong increase in the upbuilding as a result of the higher upbuilding rate times the number of future years, was compensated for by the decrease in the wage-base, as a function of the number of future years that a lower pension (based on the average wage at 65) is built up. However, in the case of the WW&O-pension, this is no longer the case. In fact, equation A2.31 shows that the surviving partner of an civil servant which dies before the retirement age, receives:

$$(up + 65 - age) \times 0.0175 \times \frac{5}{7} \times DISC_i \qquad \textbf{(A2.31)}$$

Including α results in:

$$(\frac{up}{\alpha} + 65 - age) \times 0.0175 \times \alpha \times \frac{5}{7} \times DISC_i$$

which would work out fine, as in the case of the old-age pension benefit, if *DISC* had been based on the expected wage-base at 65. However, it is not. Equation A2.30 clearly shows that it is based on the wage-base in the future year *i*. The main reason why the derivation of α went so smoothly in the above stylized example for the old-age pension benefit was that the old-age pension benefit becomes effective in the future year when the individual reaches 65. So, whatever age the transition from FW to AW may occur, the sum of the periods before and after the transition, will always be (65-25). In the case of the WW&O-pension benefit, this is not the case, however. In any future year, the WW&O-pension benefit may become effective as a result of the death of the beneficiary. So, in the year of the transition, *DISC* is fully based on the final wage FW. The next year (i.e. at i=age+1) it will decrease very slightly, since the individual will have contributed to an average wage scheme for one year, whereas he or she will have contributed to a final wage scheme for all the years between entering the fund and the year that the fund switched to an average wage scheme. So, the wage-base (and, as a result, *DISC*) will decrease only very gradually, whereas the upbuilding will increase very considerably, caused by the fact that all the future upbuilding years are suddenly increased by the factor α. Moreover, the younger the individual is, the more future upbuilding years he or she has, and therefore the more important this increase will be. And thirdly, the 'weights' will gradually shift towards the average wage, for the number of years that an individual will have been building up a pension based on the final wage scheme decreases relative to the number of years that he builds up a pension based on the average wage scheme. So, the adjustment of the upbuilding rate, α, should shift over time as well. Basically, this is the same line of reasoning as in the case of the 'actual' model. So, we have three problems with the actuarial expected WW&O-pension benefit if we adjust the upbuilding speed 0.0175 by α: not only will the adjustment of the upbuilding years by α have a strongly increasing effect on the expected future WW&O-pension claim, but this effect will differ according to age as well. And, thirdly, as this transition will only occur gradually, a sudden adjustment of the individual α to its new long-term level would considerably overcompensate the actuarial future WW&O-pension claim in the short run. So, even the individual α -if we were to decide to adopt one- would have to be adjusted gradually. Of course, these requirements on α are far distant from any practical implementation, so it was decided not to adjust the upbuilding rate at all.

Appendix 4: on Monte Carlo variance and the starting value.

Given his or her characteristics, whether or not a certain variable describing an individual changes is dictated by comparing a random number with an exogenous transition probability. This is the essence of dynamic microsimulation: all variables are either determined by these random numbers or set directly by other variables. So, in the end, the whole development of the population in the microsimulation model is determined by a string of randomly selected numbers, one for each individual and each point in time.

However, it is relatively CPU-consuming to draw a random number from a uniform distribution between zero and one. So, if this were to be done for each individual and each point in time, the model would end up running for weeks just to calculate one run, whereas we need fifteen runs. To overcome this, each number in the chain has been defined as a function of the previous number in the chain, which in turn is a function of its predecessor, and so forth. Each number in the chain is therefore indirectly a function of the starting value in the chain. If this starting value is randomly selected, then all the numbers in the chain are as well. But if we have two chains with the same starting value, the chains will be exactly the same.

A simulation variant is described by 15 runs, this to show the Monte Carlo variance and to prevent outliers. So, for the description of such a variant, we need 15 randomly-selected starting values. Now suppose that such a base-variant has been calculated, and a simulation variant has been developed where, say, the endogenous contribution rate has been replaced by a fixed contribution rate. Usually, when calculating the fifteen runs of this simulation variant, the same starting values are used as in the case of the base-variant. This way, the fifteen runs of the base-variant and those of the simulation variant are exactly the same, but for the effect of the changed contribution rate. So, by imposing the same starting values, the ceteris paribus clause is forced upon the model: as long as the same starting values are used, the 'rest of the model' will remain exactly the same in the simulation variant as in the base-variant.

This is how it is usually done, often without much discussion or thought. But this study is an exception: here, new starting values were randomly selected for each simulation variant. Of course, by basing a simulation variant on other starting values as the base-variant, the 'fit' between both variants will become less good, and comparison will be less straightforward.

The rest of this appendix will be devoted to explain why this has nevertheless been done. The proposition is that a careful examination of the role of these starting values does not lead to the unambiguous conclusion that simulation variants should be described by exactly the same starting values as the base-variant. This proposition will be defended using both fundamental and practical arguments, in the hope that it will trigger a discussion on the use of these starting values in dynamic microsimulation models. The main argument will be that the use of the same starting values indeed makes the comparison of simulation variants more straightforward, but that this is just an appearance.

One of the reasons why this is so, is that the choice of the starting values in the base-variant is crucial, not only to the base-variant itself, but to all other variants. So, if there is an outlier in these fifteen starting values, then all simulation variants will exhibit the consequence of this outlier. The result is that this outlier will not reveal itself. One could argue that, if this outlier affects the base-variant and the simulation variant in exactly the same way, it will not affect the comparison of these variants. Consequently, conclusions drawn from this comparison will not be affected by the outlier. But we do not know whether or not this assumption is true, so that conclusions will to an unknown extent be based upon a possible outlier, of which it is unknown whether or not it exists and, if so, what effect it has. If, on the other hand, new randomly-selected starting values are used for every simulation variant, then strong outliers will be revealed (as they have been), since they disturb the comparison between the simulation variants. So, if there are large differences between these variants which cannot be explained by theory, one could check for outliers by re-running both variants using new random starting values. Of course, this is very time-consuming, but it is the only way in which one can rule out the existence of (large) outliers with a minimal degree of certainty.

One apparent drawback of using new starting values for every simulation variant is that the ceteris paribus clause is not as strongly imposed as in the case where the same starting values are used. This way, the comparison of the base-variant with any simulation variant is blurred. This is, of course, true, but, again, this certainty is only apparent. First of all, the fact that the series underlying the different runs are all truly random allows us to use statistical methods to test for the significance of changes. This way, the certainty of our conclusions is improved by the use of the t-test. This brings us to the next argument in favour of using different randomly-selected starting values for each simulation variant, namely, that it causes the simulation results to be selected in terms of their importance. To see why this is, consider the case where simulation results are based on the same starting-values. In this case, all effects -important or less important- will be revealed and will have to be explained, which is a virtually impossible task given the nature of microsimulation. On the other hand, if simulation results are based on different sets of starting values, only the main effects of the simulation variant will be revealed by the statistical tests, so that the reader concentrates on what is important and does not lose him- or herself in numerous differences which are less important in the light of the problem definition. If the same starting values are used for different simulation variants, there is no way in which we can tell whether or not the simulation results are important or not.

Moreover, the empirical strength of the main effects such as they were predicted by the theory model, shows the quality of the model. So, if we use the same starting values, we lose an indirect measure of the quality of the model, being its ability to show the main effects of the simulation variant given the disturbance caused by Monte Carlo variance.

In short, when different random starting values are used instead of the same starting values, the informative value of the simulation variant does not decrease, as is commonly believed. But the results do not appear as clearly as in the second case (fixed starting values): instead, statistical techniques such as t-tests are necessary to show the importance of the effects. But the way in which these results are presented, namely in a 'sea' of Monte Carlo variance, appears more modest (a modesty which is well-placed, given that we are in essence dealing with a large black box), selects between important and unimportant effects and, last but not least, shows the danger of outliers instead of hiding it and pretending that it does not exist.

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